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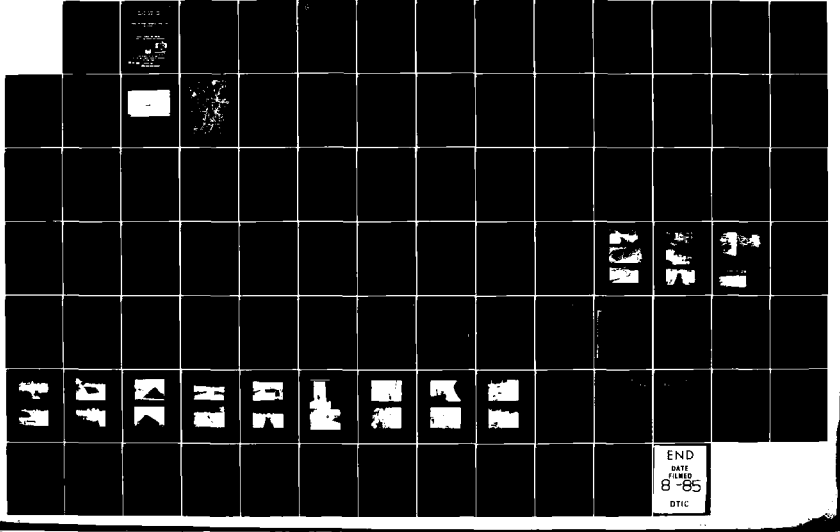

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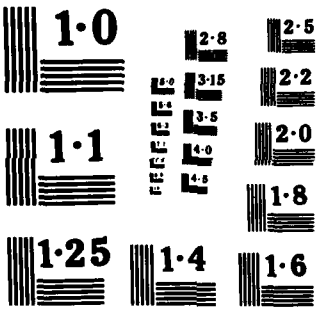
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PAWTUXET RIVER BASIN
CRANSTON, RHODE ISLAND

CRANSTON PRINT WORKS POND DAM
RI 00701

PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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4. TITLE (and Subtitle) Cranston Print Works Pond Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Pawtuxet River Basin
Cranston, Rhode Island
Pocasset River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is a stone-faced earth embankment dam that is about 17 ft. high and 350 ft. long. The dam is considered to be in fair condition. There are some areas of ocncern which must be corrected to assure the long term performance of the dam. It is small in size with a high hazard potential. The test flood for the dam is the full PMF. There are various remedial measures which must be undertaken by the owner.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED-E

JUL 25 1980

Honorable J. Joseph Garrahy
Governor of the State of Rhode Island
State House
Providence, Rhode Island 02903

Dear Governor Garrahy:

Inclosed is a copy of the Cranston Print Works Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Cranston Print Works Pond Dam would likely be exceeded by floods greater than 14 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Our screening criteria specifies that a dam of this class which does not have sufficient spillway capacity to discharge fifty percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The term "unsafe" applied to a dam because of an inadequate spillway does not indicate the same degree of emergency as that term would if applied because of structural deficiency. It does indicate, however, that a severe storm may cause overtopping and possible failure of the dam, with significant damage and potential loss of life downstream.

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy preciptiation, round-the-clock surveillance should be provided.

NEDED-E
Honorable J. Joseph Garrahy

I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Department of Environmental Management, the cooperating agency for the State of Rhode Island. This report has also been furnished to the owner of the project, Cranston Print Works Company, 1381 Cranston Street, Cranston, Rhode Island.

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Management for the cooperation extended in carrying out this program.

Sincerely,

MAX B. Scheider
Colonel, Corps of Engineers
Division Engineer

CRANSTON PRINT WORKS POND DAM

RI 00701

PAWTUXET RIVER BASIN

CRANSTON, RHODE ISLAND

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I - INSPECTION REPORT

IDENTIFICATION NO.:	RI 00701
NAME OF DAM:	Cranston Print Works Pond Dam
COUNTY AND STATE:	Providence County, Rhode Island
STREAM:	Pocasset River
DATE OF INSPECTION:	7 November 1979

BRIEF ASSESSMENT

The Cranston Print Works Pond Dam is a stone-faced earth embankment dam constructed about 1825 and is used to supply process water at the textile print works mill located downstream of the dam. The dam has a height of 17 feet and is approximately 350 feet in length (including the spillway). The spillway is a granite cascade type, uncontrolled broad crested weir, 100 feet in length. The outlet works consists of a 42-inch diameter conduit with a manually operated sluice gate located on the right spillway abutment, that discharges into the spillway discharge channel; and a rectangular head-race gate located at the left abutment and presently used as a source of process water for the mill. Due to its age, Cranston Print Works Pond Dam was neither designed nor constructed by present state-of-the-arts procedures.

Based on the visual inspection at the site, the dam is considered to be in FAIR condition. However, there are some areas of concern which must be corrected to assure the long term performance of this dam, particularly if the history of engineering, operations and maintenance data are unrecorded. Signs of concern which may indicate a potential hazard are seepage emerging along the right downstream spillway discharge channel training wall and around the perimeter of the outlet conduit; evidence of movement along the stone face of the left upstream dam embankment; and seepage at the junction of the downsteam masonry face of the left dam embankment and the masonry face on the downstream right side of the headrace.

The dam is classified as small in size and a high hazard structure in accordance with recommended guidelines established by the Corps of Engineers. Based on the size and hazard classification, the test flood for this structure ranges from the one-half (PMF) Probable Maximum Flood to the full PMF. The full PMF was adopted as the test flood for Cranston

Print Works Pond Dam because of the potential damage downstream. Calculations indicate that the test flood outflow of 12,400 cfs (704 CSM) would overtop the dam by about 5.2 feet; therefore, the spillway capacity is considered inadequate. Assuming the pool elevation at the top of the dam, the spillway can pass a flow of 1,715 cfs, which represents only 13.8 percent of the test flood outflow.

It is recommended that the Owner engage the services of an engineer experienced in the design of dams to accomplish the following:

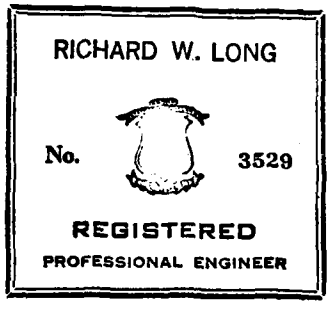
Conduct further study of the hydraulic and hydrologic aspects of the drainage basin to provide alternate means of reducing overtopping potential at the dam. Evaluate and determine the cause for the movement of the upstream masonry face at the left dam embankment and institute a program to repair and prevent further failure to the masonry face; examine in detail the seepage through the right dam embankment at the outlet conduit and spillway discharge training wall to determine their effects on the structural stability of the dam;

The above recommendations and other remedial measures as described in Section 7 should be implemented by the owner within one year after receipt of this Phase I Inspection Report.

CE MAGUIRE, INC.

Richard W. Long

Richard W. Long, P.E.
Vice President



This Phase I Inspection Report on Cranston Print Works Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions and is evolu-

tionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff) or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

c. Appurtenant Structures. The appurtenant structures for this dam are the overflow spillway, the control gate outlet works structure, and the gated headrace.

1. Spillway and Training Walls - The spillway is a broad-crested stone masonry cascade type, uncontrolled overflow structure. Water was overflowing the spillway at the time of the inspection.

As shown in Photo C-3, the alignment of the stone steps on the downstream face of the spillway appears to be good. No displacement was noted.

The spillway training walls as shown in Figure C-5 and C-6 are in good condition, with no misalignment or tilting.

2. Outlet Works - The outlet works gate and gatehouse is located at the right spillway abutment and can be seen in Photos C-11 and C-12. The original gate structure and conduit were replaced in 1978 and construction drawings for this repair are included in Appendix B. A new concrete block gatehouse was constructed and new sluice gate and conduit installed during this repair. The new 42-inch diameter conduit was inserted through the existing 4-foot diameter steel pipe and the annular ring grouted. Future plans at the Cranston Print Works Mill call for the addition of a low head generating turbine to be added to the outlet works. The gate was exercised during the inspection and appeared to be in good working condition and well lubricated.

Flow from the outlet conduit discharges directly into the spillway discharge channel slightly to the right side of the spillway.

Seepage was observed flowing under the 4-foot diameter outlet conduit at the downstream stone face of the right dam embankment (see Photo C-15).

3. Gated Headrace - The headrace as shown on Plate 2 is located at the dam's left abutment and consists of a gate structure and an open granite block rectangular channel perpendicular to both the upstream and downstream stone faces of the left dam embankment. Photo C-9 shows the deteriorated condition of the concrete base for the gate mechanism at the upstream side of the headrace. No plans were available for either construction or records of repair for this structure.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The phase I inspection of the dam at Cranston Print Works Pond was performed on November 7, 1979, by representatives of CE Maguire, Inc. and Geotechnical Engineers Inc. Based on the visual inspection, limited history, and general appearance, the dam and its appurtenances at Cranston Print Works Pond are judged to be in FAIR condition.

b. Dam. The dam is a stone-faced earth embankment structure approximately 350 feet long, 17 feet high, with a typical crest width of 47 feet. No construction drawings are available, nor are the details of design and subsequent repairs known.

Correspondence indicates that some repair was completed on or around the western abutment during the summer months of 1947. No plans or design documents are available for the repair.

1. Crest and Stone Face Retaining Walls - The crest of the earth embankment section of the dam is very broad and well-defined between the upstream and downstream vertical masonry stone faces. (See photos C-1,2)

The spillway divides the dam embankment into two sections, the right and left embankments, with the headrace located at the dam's left abutment.

The right embankment supports the outlet works gatehouse and outlet conduit. (See overview photo). Some erosion of the crest is evident in the area of the right dam abutment (See photo C-17) due to a lack of cover protection and unauthorized trespass. The vertical stone masonry walls are in good condition with some vegetation growing in the stonework (see Photo C-12).

The left embankment which is longer than the right (see Plate 2) joins the spillway and the headrace which is at the dam's extreme left abutment. The grouted masonry wall of the upstream face at the left dam embankment has joints without mortar and is leaning slightly into the reservoir (see Photo C-13). There has been about two inches of vertical displacement between the blocks on top of the wall. Some small trees and large bushes are growing on the crest of the dam (see Photos C-4,18). There is a gap in the downstream face of the masonry wall of the left embankment and some erosion has occured from under the top blocks of the wall. (See Plate B in Appendix B-3.

SECTION 2

ENGINEERING DATA

2.1 Design Data

Several sketches depicting sections taken through the dam are available, but their origin and date are unknown. (See Appendix B). No other design data is available for this dam.

2.2 Construction Data

No record of original construction is available for this dam. Some records pertaining to repair work since 1939 are available. These records consist of correspondence and visual inspection reports. Construction drawings for repair work performed in 1978 as well as other selected repair inspection reports have been included in Appendix B of this report.

2.3 Operation Data

No records are maintained of gate operation.

2.4 Evaluation of Data

a. Availability. There are limited plans, and no specifications or computations available from the Owner regarding the design of this dam. Limited correspondence pertaining to repair work and field inspections, and certain contract documents are available from the Owner (The Cranston Print Works Company) and the Rhode Island Environmental Management Department.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance, and sound engineering judgment.

c. Validity. The validity of the limited data must be verified.

3.	Description	Cast iron pipe
4.	Control Mechanism	Manually operated sluice gate enclosed in gatehouse
5.	Other	Headrace gate used to withdraw process water from pool. Gate is not regulated and flow is further regulated by small diameter pipe. Estimated discharge through headrace is insignificant.

7.	Impervious core	Unknown
8.	Cut-off	Unknown
9.	Grout curtain	Unknown
10.	Other	N/A
h.	Diversion and Regulating Tunnel	N/A
i.	Spillway	
1.	Type	Cascade free-overflow uncontrolled constructed of cut granite masonry.
2.	Length of weir	100 feet
3.	Crest elevation	66.63
4.	Gates	None
5.	U/S Channel	Resevoir bed; straight approach
6.	D/S Channel	Rectangular concrete open channel with natural stream bed
7.	General	
j.	Regulating Outlets	
	Refer to Paragraph 1.2b, "Description of Dam and Appurtenances" Page 3 for description of outlet works.	
1.	Downstream invert	54.31
2.	Size	42-inch diameter

1.	Normal pool	N/A
2.	Flood control pool	N/A
3.	Spillway crest	180
4.	Test flood elevation	435
5.	Top of dam	255

6. Net storage between top of dam (elevation 69.63) and spillway crest is 75 Ac-Ft. and represents 0.08 inches of runoff from the drainage area of 17.6 square miles.

7. Each foot of surcharge storage between spillway crest and top of dam equals 0.025 inches of runoff from the drainage area of 17.6 square miles.

f. Reservoir Surface (acres)

1.	Top dam	33
2.	Test flood pool	40
3.	Flood control pool	N/A
4.	Recreation pool	N/A
5.	Spillway crest	25.0

g. Dam

1.	Type (based on visual inspection)	Earthen dam embankment with masonry faces
2.	Length (including 100 feet of spillway)	350 feet
3.	Height	17 feet
4.	Top width	47 feet
5.	Side slope	Vertical Stone Face
6.	Zoning	Unknown

2. Maximum known flood at damsite = Unknown

3. Ungated Spillway Capacity = 1715 C.F.S at top of dam.

4. Total Project discharge at top of dam = 1897 C.F.S (Spillway plus outlet discharge)

5. Dam outflow discharge = 12400 C.F.S at Test Flood level (Spillway plus dam overflow).

6. Total Project discharge = 12619 C.F.S at Test Flood level. (Spillway plus dam overflow plus outlet discharge)

* Discharges calculated assuming headrace gate closed.

c. Elevations (feet above NGVD)

1.	Streambed at toe of dam	52.63
2.	Bottom of cut-off	Unknown
3.	Maximum tailwater	Unknown
4.	Recreation pool	N/A
5.	Flood control pool	N/A
6.	Spillway crest	66.63
7.	Design discharge (original design)	Unknown
8.	Top of Dam	69.63
9.	Test flood	74.79

d. Reservoir (Length in feet)

1.	Normal pool	3000 ft.
2.	Flood control pool	N/A
3.	Spillway crest pool	3000 ft.
4.	Top of dam pool	indeterminate
5.	Test flood pool	indeterminate

e. Storage (acre-feet) total

the dry period of the summer months. No record of any repair work was maintained, however. Most recent correspondence and plans denote improvements made during 1978. The pond was lowered and a new sluice gate, gate house, and outlet conduit were added at this time. This work was reportedly designed by the Cranston Print Works' in-house engineering staff.

i. Normal Operational Procedures. There is no regulation of the water surface at the Cranston Print Works Pond. Flows are normally allowed to discharge over the uncontrolled spillway and process water (approximately 3,000 gallons per day) is withdrawn from the headrace.

1.3 Pertinent Data

a. Drainage Area. The Cranston Print Works Dam drainage basin, located in Providence County in Cranston, is irregular in shape with a length of 30000 ± feet, a width of 16000 ± feet, and a total drainage area of 17.6 square miles (See Appendix D for Basin Map). Thirty percent of the watershed (5.3 square miles) is swampy or occupied by natural water storage ponds or lakes. The topography is generally flat to moderate with the elevations ranging from a high of 433.0 NGVD to 66.63 at the spillway crest. Basin slopes are 0.02 to 0.04 ft/ft and are generally flat to moderate. The time of concentration for the entire watershed is approximately 120 minutes and is relatively small, increasing the probability that all surface runoff will peak simultaneously at the reservoir site during a high intensity rainfall event. However, the large percentage of storage areas in the watershed tend to appreciably dampen and delay the peak of the surface runoff.

b. Discharge at Damsite. There is limited discharge data available for this dam. Estimated extreme freshet recorded in the files of the Department of Environmental Management for this dam is 1,584 cfs. Listed below are discharge data for spillway and outlet works.

1. Outlet works:

Conduit size = 42" diameter C.I. pipe Invert Elevation = 54.31

i) Discharge Capacity = 161.0 C.F.S at Spillway Crest Elevation 66.63
ii) Discharge capacity = 182.0 C.F.S at Top of Dam Elevation 69.63
iii) Discharge Capacity = 219.0 C.F.S at Test Flood Elevation 74.79

overflow spillway), about 17 feet high with an average crest width of 47 feet, and is a stone-faced earth embankment. The spillway is a cascade type constructed of cut stone masonry and is an uncontrolled overflow weir about 100 feet long, located approximately 46 feet from the right abutment of the dam. There are two outlet works structures for this dam: one, located at the right spillway abutment, is a gated 42-inch diameter conduit. The other, also gated, is a rectangular open channel headrace leading to the mill complex. Discharges from the spillway and outlet works flow into the Pocasset River and further downstream into the Pawtuxet River.

c. Size Classification. Cranston Print Works Pond Dam has an impoundment capacity at the top of the dam (elevation 69.6 NGVD) equal to 225 Ac-Ft. and a maximum height of 17 feet. Recommended guidelines warrant this dam to be classified as a SMALL structure.

d. Hazard Classification. The dam is classified as a HIGH hazard structure because its failure may cause loss of more than a few lives, property damage to 6-10 industrial buildings including office equipment, machinery and inventories and damage from flooding to 10-15 dwellings in the Highland Park area. Cranston Street and several residential streets, including the overhead utilities within the rights-of-way, will also experience damage and flooding. See Appendix D for failure analysis.

e. Ownership. The Cranston Print Works Pond Dam is owned by the Cranston Print Works Company, 1381 Cranston Street, Cranston, Rhode Island.

f. Operator. Operating personnel are under the direction of the plant's engineering department.

Mr. Cliff Hopkins, Plant Engineer
1381 Cranston Street
Cranston, Rhode Island 02920

g. Purpose of Dam. The Cranston Print Works Dam was built around 1825 for the Sprague Print Works Company to provide a source of process water for textile printing. The impoundment created by the dam is now used as a process water source by the present Owner, the Cranston Print Works Company.

h. Design and Construction History. Cranston Print Works Pond Dam was reportedly constructed around 1825. Earliest records indicate that about 1883 a substantial leak appeared under the western embankment which permeated the entire gravel ridge. Later, other correspondence in 1947 indicated that more leaks appeared in this same location during construction of a new wall and that the owners were going to attempt repairs during

NATIONAL DAM INSPECTION PROGRAM

PHASE I-INSPECTION REPORT

NAME OF DAM: CRANSTON PRINT WORKS POND DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army through the Corps of Engineers to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. CE Maguire, Inc., has been retained by the New England Division to inspect and report on selected dams in the State of Rhode Island. Authorization and notice to proceed was issued to CE Maguire, Inc. under a letter from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-80-C-0013 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection.

1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

2. Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

3. To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

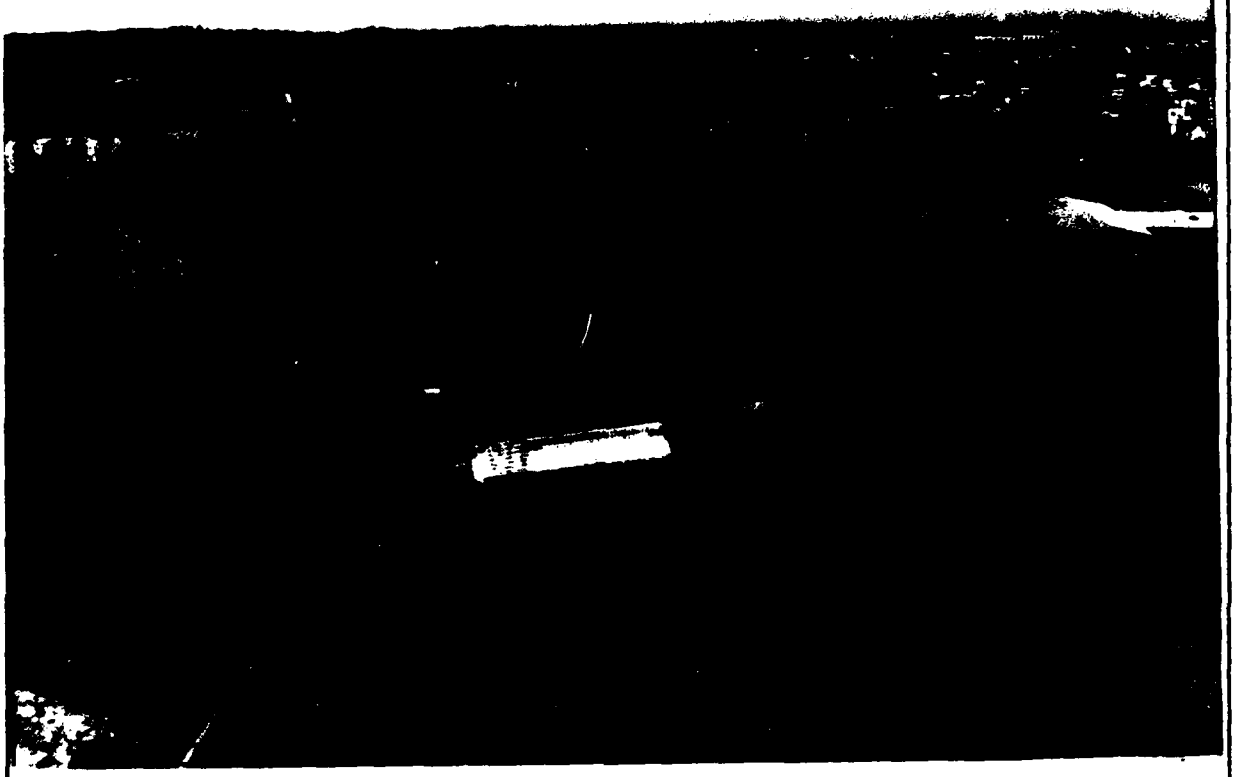
a. Location. The dam at the Cranston Print Works Mill complex is located in the City of Cranston in Providence County, Rhode Island. (See Plate No. 1). The damsite is at the south extremity of Print Works Pond between St. Ann's Cemetery and Dyer Avenue and in the northern portion of the Cranston Print Works' property at 1381 Cranston Street. The structure impounds water from the Pocasset River and is located approximately 2.8 miles upstream from the confluence of the Pocasset River and the Pawtuxet River. Coordinates of the dam are approximately 41° 47.6' N Latitude and 71° 27.6 W Longtitude.

b. Description of Dam and Appurtenances. The dam at Cranston Print Works Pond is approximately 350 feet long (including the

CRANSTON PRINT WORKS POND DAM

LOCATION PLAN

PLATE NO. 1



OVERVIEW PHOTO - CRANSTON PRINT WORKS POND DAM

Reportedly 3,000 gallons per day are withdrawn through the headrace by the mill to be used as process water for the textile printing processes. Photo C-10 shows a downstream view of the headrace channel.

A small saturated seepage zone was observed in the right wall of the right embankment near the downstream face of the right embankment of the dam (see Photo C-14), no flow was observed.

d. Reservoir Area. No specific detrimental features in the reservoir area were noted during the inspection except for the stone face on the upstream side of the left dam embankment as shown in Photo C-13 and described in section 3.1b.2. The slopes and banks of the reservoir appear to be well covered with vegetation. (See the overview photo and C-7).

e. Downstream Channel. The downstream channel is shown in Photo C-8. The channel is confined within concrete training walls, and the floor of the channel is gravel with small cobbles. There are some small trees and brush near the toe of the spillway. Seepage was observed along the right training wall near the toe of the right dam embankment (see Photo C-16). Rust staining and a small quantity of flow were evident. Seepage in the area of the toe of the right dam embankment was also mentioned in the 1947 dam inspection report. (See Appendix B). The mill complex is located approximately 300 feet downstream of the dam. Further downstream, a distance of 2,000 feet, the Pocasset River flows beneath Cranston Street through an arched roadway bridge opening 10ft H x 40 ft W.

3.2 Evaluation

Based on the visual inspection, the dam appears to be in fair condition. The inspection disclosed the following deficiencies which require attention.

a. Small trees and brush growing along the crest and stone faces of the dam embankment have the potential to cause seepage problems and stone displacement if left unchecked.

b. Seepage from under the outlet conduit and along the right spillway discharge channel training wall.

c. Seepage at the intersection of the downstream stone face of the left dam embankment and the right wall of the headrace channel.

d. Surface erosion along the crest at the right dam abutment.

e. Movement of the upstream stone face at the left dam embankment.

SECTION 4

OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. The water level for the Cranston Print Works Pond Dam is generally uncontrolled. Normal operating procedures allow discharges to pass over the uncontrolled spillway with the exception of approximately 3,000 gallons of water per day which is withdrawn from the pool through the headrace for process water at the mill. The sluice gate for the outlet conduit is tested periodically to insure its operational readiness, but is not used for regulating water surface levels of the pond. As a rule, the outlet works has been opened only for maintenance and repair work. No formal contingency plan for emergency operation or standby activity exists. The gate operation handle is kept in the possession of Cliff Hopkins, Plant Engineer, 1381 Cranston Street, Cranston, Rhode Island.

b. Description of Any Warning System in Effect. No formal emergency plan is in effect to reduce or minimize downstream damage in emergency situations for Cranston Print Works Pond Dam. If emergency action or an alert for the City of Cranston were required, the local police and City Civil Defense personnel would be notified by personnel at the Cranston Print Works Company.

4.2 Maintenance Procedures

a. General. The crest and downstream areas of the dam are periodically cleared of brush by the Owner, but there is no regularly scheduled maintenance program for the dam and its appurtenances. As shown in Photos C-2 and C-4, there are some small trees and brush growing on and around the dam.

b. Operating Facilities. The operating outlet works, gate, gatehouse and foundation, trash rack, and discharge conduit were replaced during 1978. The sluice gate was operated for the outlet works during the visual inspection of the dam, and it was noted that there was some leakage around the outside of the outlet conduit at the downstream face of the dam.

The operating condition of the headrace control gate is unknown and it was not operated at the time of the visual inspection. The gate reportedly is not operated for releases from the pool. The concrete base for the headrace gate mechanism is badly spalled and in need of repair (See Photo C-9). There is no schedule of maintenance for any of the dam's operating facilities.

4.3 Evaluation

Deficiencies exist in the dam maintenance program as it now exists.

a. Trees and other vegetation growth are taking hold on the crest and stone faces and should be cleared before they reach excessive size.

b. Erosion on the downstream side of the right dam embankment should be repaired and protected.

c. An Emergency Action Plan should be developed to prevent or minimize the impact in the event of failure. Such a plan should list the expedient actions to be taken and authorities to be notified.

d. Implement a scheduled program to monitor conditions of the dam on a regular basis and during extreme weather conditions which could threaten the dam or downstream areas.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Cranston Print Works Pond Dam was constructed about 1825 for storing process water to be used in an adjacent textile mill and is located on the Pocasset River in the Pawtuxet River Basin. This dam has a watershed area of 17.6 square miles. Typical basin characteristics of this watershed are flat slopes and large natural storage areas, (30 percent of the total drainage area). The physical features of the basin such as shape, slope, length and large bodies of natural storage dictate a low value of runoff at the dam. There is no gaging station located in the contributing area of this watershed.

The dam has a spillway length of 100 feet and an available surcharge height of 3.0 feet between the top of the dam and the spillway crest. The total length of the dam is 350 feet. The reservoir has a total storage capacity of 180 Ac-Ft. at the spillway crest level elevation 66.63 and can accommodate 0.19 inches of runoff from a drainage area of 17.6 square miles.

Because 75 Ac-Ft. of storage equivalent to 0.08 inches of runoff is available in surcharge storage, this dam is basically a small storage facility. The maximum spillway capacity of 1,715 cfs is only 13.8 percent of the test flood for the full PMF which makes the dam a high spillage structure. The dam being a stone faced earthen type embankment is less stable against overtopping due to erosion than other structures.

5.2 Design Data

No known specific design data is available for this watershed. In lieu of the existing design information, U.S.G.S. topographic maps (Scale 1" = 2,000') were utilized to develop hydrologic parameters such as drainage area, reservoir surface area, basin slopes, time of concentration and other runoff characteristics. Elevation - storage relationships for the reservoir were approximated. Surcharge storage was computed assuming that the surface area remained constant above the spillway crest. Some of the pertinent hydraulic design data was obtained and/or confirmed by actual field measurement at the time of the visual field inspection.

Test flood inflow/outflow values and the dam failure profile were determined in accordance with the Corps of Engineers guidelines. Final values in this report are quite approximate and are no substitute for actual detailed analysis.

5.3 Experience Data

No historical data for recorded discharges or water surface elevations is available for this dam or the watershed. Cranston Print Works personnel do not recall any overtopping of the dam.

5.4 Test Flood Analysis

Recommended guidelines for the safety inspection of dams by the Corps of Engineers were used for selection of the "Test Flood". This dam is classified under those guidelines as a HIGH hazard and SMALL size. Guidelines indicate a flood event equal to one half the PMF to the full PMF as a range of test floods for such classifications. The watershed has a total drainage area of 17.6 square miles, of which, 5.3 square miles (30 percent) is swampy or covered by storage reservoirs in the watershed. The average basin slope is .03± ft/ft. which is considered flat. A "test flood" equal to the full PMF was calculated to be 770 CSM, equal to 13,520 cfs. Outflow discharges were also developed using the Corps' criteria and approximate routing techniques. Outflow discharges for the test flood inflow were equal to 12,400 cfs. The spillway and outlet rating curves are illustrated in Appendix D. Flood routings were performed with an assumed initial condition of a full reservoir at the spillway crest elevation.

It was found, based on these calculations that the spillway capacity is hydraulically inadequate to pass the "test flood" (full PMF) and overtopping at the dam approximately 5.16 feet, assuming the overflow length of the dam is 350 feet, would occur. The inflow and outflow discharge values for this test flood are 13,520 cfs and 12,400 cfs, respectively. The maximum outflow capacity of the spillway, in a still reservoir condition, without overtopping of the dam is 1,715 cfs which is only 13.8 percent of the test flood overflow discharge.

At the spillway crest level (elevation 66.63 feet), the capacity of the outlet structure is equal to 161 cfs. It will require 2 hours to lower the reservoir pool level the one foot assuming a pool surface area of 25 acres. The 180 acre-feet of available storage below the spillway crest will require one day to drain using the existing outlet, if required in an emergency situation.

One foot depth of reservoir at spillway crest can approximately accommodate 0.025 inches of effective rainfall. Consequently, it is estimated that overtopping of the dam cannot be eliminated by a "test flood" event.

5.5 Dam Failure Analysis

To determine the approximate consequences that would occur from dam failure at the Cranston Prints Works Pond Dam an instantaneous full-depth partial-width breach was assumed to have occurred in this

dam. This will result in an unsteady flow phenomenon with one flood wave travelling up into the reservoir to feed the other wave travelling downstream into the valley.

The calculated dam failure discharge of 4253 C.F.S. with the impounded water level at the top of the dam (Elevation 69.63 feet) will produce an approximate water surface flood wave stage of Elevation 62.80 feet immediately downstream from the dam. This wave will raise the water surface approximately 3.6 feet above the depth just prior to failure when the discharge is 1715 C.F.S. This failure analysis considered the reach extending from the dam to a point 2000 feet downstream. Normal uniform flow, following Manning's formula will occur at that point with a depth of flow equal to 8.60 feet based on the assumption that the Cranston Street Bridge structure will withstand the wave impact. For the distance of 2000 feet from the dam, the depth of flow will change from 6.7 feet to 8.6 feet. The failure discharge will diminish as the reservoir is emptied and the pool depth decreased. The river valley storage and frictional losses will tend to reduce the discharge and flow velocities in this distance. Water surface elevations due to failure of the dam are computed and are listed in Appendix D.

The dam is classified as a HIGH hazard structure because its failure may result in the loss of more than a few lives, property damage to 6-10 industrial buildings including office equipment, machinery and inventories, and damage from flooding to 10-15 dwellings in the Highland Park area. Cranston Street and several residential streets, including the overhead utilities within the rights-of-way, will also experience damage and flooding.

Probable consequences including the prime impact area, if the dam were to fail, are also listed in Appendix D. It is estimated that the maximum depth of flow due to the failure of this dam will be 8.6 feet and the maximum velocity will be 29.0 ft./sec.

CRANSTON PRINT WORKS DAM
Inflow, Outflow and Surcharge Data

FREQUENCY IN YEARS	24-HOUR TOTAL RAINFALL IN INCHES	24-HOUR* EFFECTIVE RAINFALL IN INCHES	MAXIMUM INFLOW IN CFS	MAXIMUM** OUTFLOW IN CFS	SURCHARGE HEIGHT IN FEET	SURCHARGE STORAGE ELEVATION
½ PMF	11.9	9.5	6,760	6,700	6.40	73.03
TEST FLOOD = PMF	21.4	19.0	13,520	12,400	8.16	74.79

*Infiltration assumed as 0.1"/hour
**Lake assumed initially full at spillway crest elevation 66.63 (top of dam = 69.63)

NOTES:

1. ½ PMF and "test flood" computation based on COE instructions and guidelines.

2. Maximum capacity of spillway without overtopping the top of the dam elevation (69.63) is equal to 1,715 cfs.

3. All discharges indicated are dependent upon the continued integrity of upstream storage reservoirs.

4. Surcharge storage is allowed to overtop the dam when exceeding the spillway capacity.

5. Test flood = Full PMF = 770 CSM = 13,520 CFS (D.A. = 17.6 square miles).

6. Above values calculated assuming outlet works closed.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observation

The visual observations did not disclose any indications of overall instability. Roots of trees growing on the crest of the dam next to the walls can cause displacement and loss of stone blocks. Erosion at the junction of the right abutment and the wall on the downstream face of the right section of the dam may cause movement of the blocks of the wall in this area. The upstream stone face of the left dam embankment shows movement and the potential for collapse in the future.

6.2 Design and Construction Data

There is no available design and construction data.

6.3 Post-Construction Changes

The only known post-construction change consists of the insertion of the 42 inch diameter pipe inside the existing 4-foot diameter outlet pipe, a new sluice gate, gatehouse, and trash rack. This change does not affect the structural stability of the dam.

A representative of the Print Works indicated that a hydro-power electrical generation system was planned to be constructed in the near future. The system will be connected to the 3.5-foot diameter pipe. The plans of the system should be evaluated to determine if the construction or operation of the generation system will affect the structural stability of the dam.

6.4 Seismic Stability

The dam is located near the boundary of Seismic Zones 1 and 2 and, in accordance with the recommended Phase I inspection guidelines, does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicated that the Cranston Print Works Pond Dam is in FAIR condition. The major concerns regarding the long-term performance of this dam include:

1. Tree and brush growth on the crest and stone faces with attendant root systems.
2. Seepage flowing from around the outlet conduit.
3. Movement of the upstream stone face of the left dam embankment due to failure.
4. Erosion of the dam crest at the right dam abutment.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data; but it is based primarily on the visual inspection, past performance history, and sound engineering judgment.

c. Urgency. The recommendations and remedial measures described below should be implemented by the Owner within 1 year after receipt of this Phase I Inspection Report.

7.2 Recommendations

The Owner should engage the services of an engineer experienced in the design of dams to accomplish the following:

a. Conduct further studies of the hydraulic and hydrologic aspects of the drainage area and dam to provide alternative solutions for reducing the overtopping potential at the dam.

b. Monitor the seepage that is occurring through the right dam embankment and around the outlet conduit for changes in flow or internal erosion of the dam.

c. Evaluate the cause of the movement of the stone face on the upstream side of the left dam embankment and implement a program to rehabilitate its repair.

7.3 Remedial Measures

a. Operation and Maintenance Program.

1. Develop a system for the recording of data with regard to items such as water levels, discharges, time and drawdown characteristics to assist those responsible for the monitoring and operation of the dam.

2. The Owner should clear the vegetation on the dam crest and stone faces of the dam. A clear area of 20 feet from the toe of the drain should be maintained, as well.

3. Provision should be taken to prevent trespassing and vandalism of the gate mechanisms for the outlet works and headrace structures.

4. Continue the technical inspections of this facility on an annual basis.

5. Develop and post an Emergency Action Plan including a warning system in order to prevent or minimize the impact of dam failure. It should include the expedient action to be taken, authorities to be contacted, and locations of emergency equipment and materials. Consider the use of stage recording or flow measuring equipment to provide early alert to the operating personnel.

6. Implement a regular program of maintenance and equipment tests.

7. Trees and brush on the crest and stone faces of the dam should be removed, the stump and roots removed, and holes compacted with proper backfill on the earth embankment and mortar on the stone faces.

8. Provide a suitable erosion protection system for the exposed area of the right dam embankment crest and downstream slope.

9. Backfill soil materials and repair masonry stone at gap in downstream wall of left embankment.

10. Repair concrete walls of headrace.

11. Inspect spillway under no flood condition.

7.4 Alternatives

There are no practical alternatives to the recommendations discussed above.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT CRANSTON PRINT WORKS POND DAM DATE Nov. 7, 1979

TIME 0900

WEATHER Sunny, cool

W.S.ELEV. 66.83 U.S. - D.S.

PARTY :

1. Leonard Topp, CEI
2. Ernest Dessert, CEI
3. Sat Khanna, CEM
4. Gonzalo Castro, GEI
5. Stephen Whiteside, GEI
6.
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT CRANSTON PRINT WORKS POND DAM DATE _____

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
DAM	Stone masonry walls on upstream and downstream faces with earth fill.
Crest Elevation	66.63 N.G.V.D.
Current Pool Elevation	66.83 N.G.V.D.
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed.
Pavement Condition	N/A.
Movement or Settlement of Crest	None observed.
Lateral Movement	Upstream wall at left abutment has upstream displacement.
Vertical Alignment	Stone Wall has minor vertical displacement.
Horizontal Alignment	Good, except at left abutment.
Condition at Abutment and at Concrete Structures.	Minor erosion at junction of downstream wall of dam and right abutment.
Indications of Movement of Structural Items on Slopes.	N/A.
Trespassing on Slopes	N/A.
Sloughing or Erosion of Slopes or Abutments.	Minor erosion in right abutment downstream of dam.
Rock Slope Protection - Riprap Failures.	N/A.
Unusual Movement or Cracking at or Near Toe.	None observed.
Embankment or Downstream Seepage.	Seep under 4' diam. outlet pipe. Three minor seeps along right wall of downstream channel from spillway. Minor seep in right wall of right embankment for raceway.

PERIODIC INSPECTION CHECK LIST

PROJECT CRANSTON PRINT WORKS POND DAM DATE _____

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

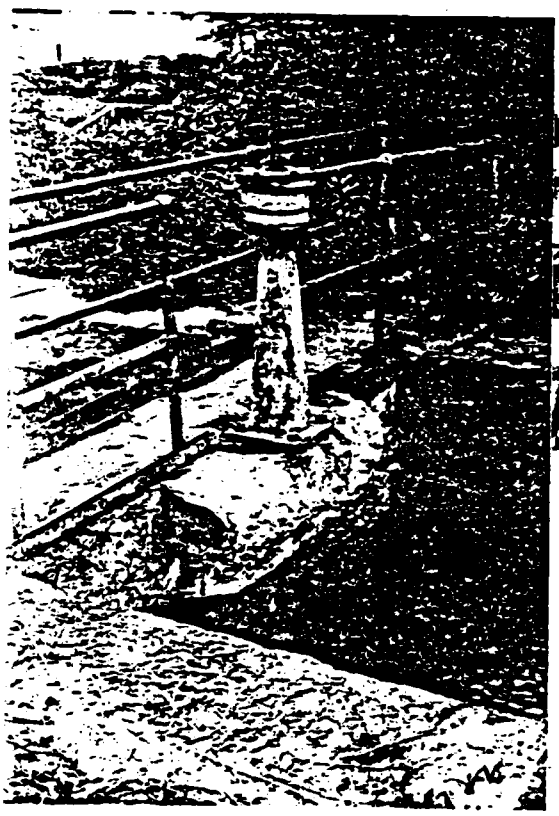
AREA EVALUATED	CONDITION
DAM Cont.	
Piping or Boils	None observed.
Foundation Drainage Features	None known.
Toe Drains	None known.
Instrumentation System	None known.
Vegetation	Small trees and bushes on crest and at downstream toe.

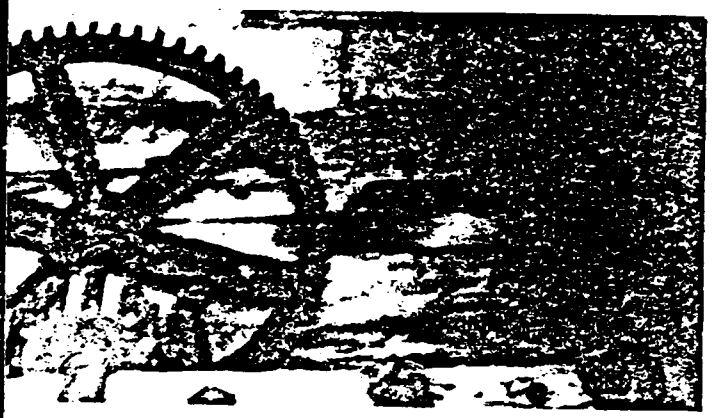
APPENDIX B-3

PLANS, SECTIONS, DETAILS

AUGUST 30, 1978

Additional photos, but not included with report.





↑ Dismantled remains of "rack & pinion" type gear mechanism at draw-off gate.

← Operating stand of gate valve to head race. (Rodney Hunt)

General view looking toward Dyer Pond, showing heavy accumulation of weeds in front of crest of spillway.

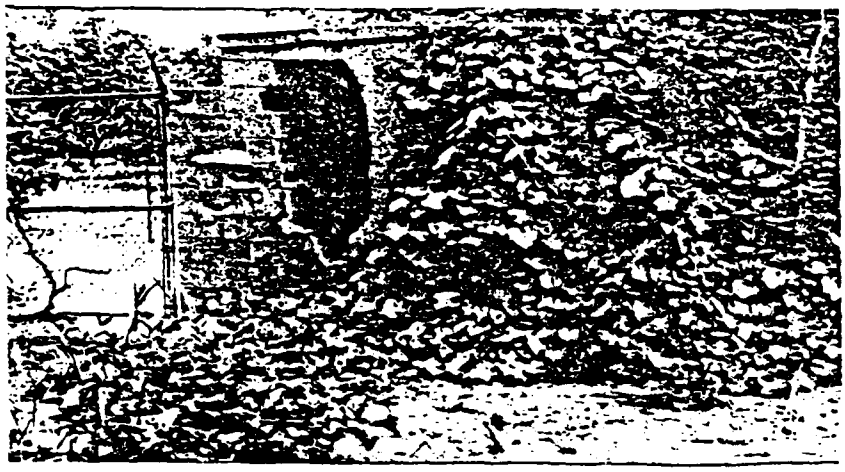


PHOTO #4. Gatehouse, showing busted out wall. Door also currently hanging off it's hinges. Gear mechanism of gates has also been dismantled.

PHOTO #5. Outlet pipe from gatestructure. Note the misalignment of granite blocks beginning to show from heavy growth of vegetation on wall.

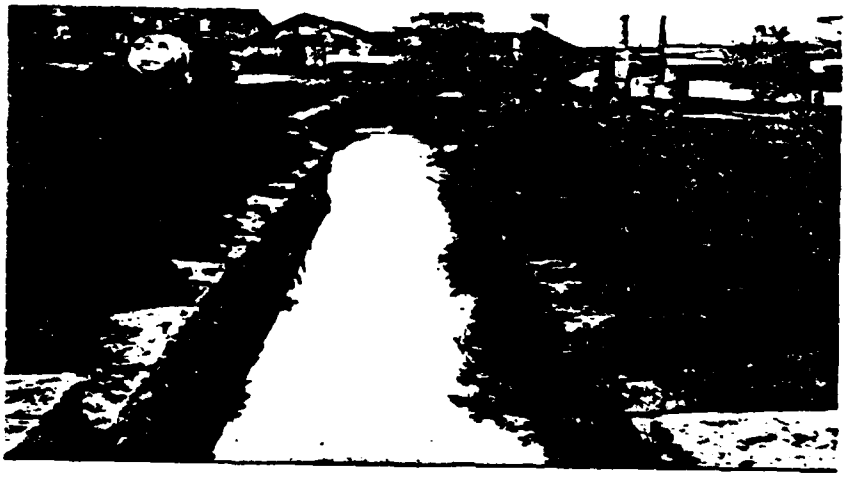


PHOTO #6. General view of headrace to mill complex.

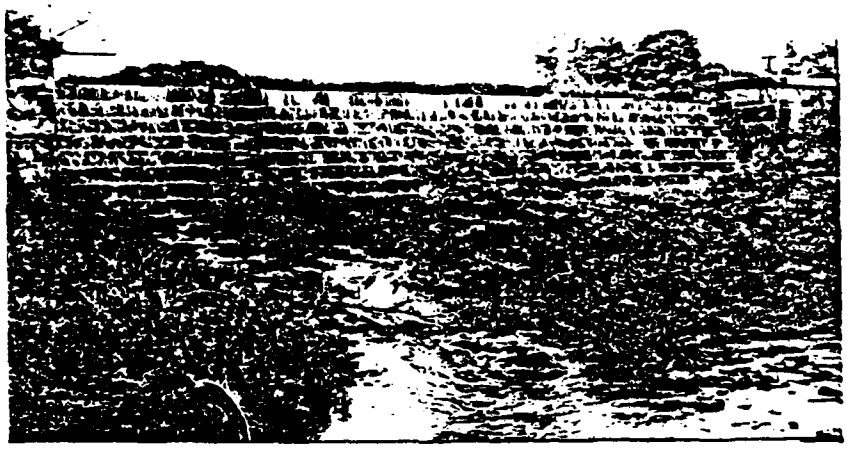


PHOTO #1. General view of stepped masonry face of spillway (also showing growth of vegetation in discharge channel).

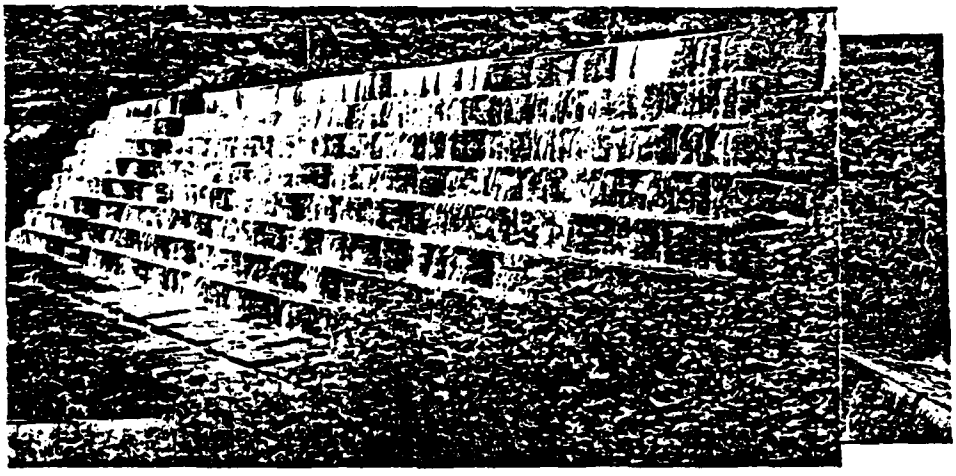


PHOTO #2. Close-up view of stepped masonry face of spillway and stone apron. (UNDER: view across crest also showing heavy growth of weeds. No irregularities noticable across crest.

PHOTO #3. General view of discharge channel(River) from spillway and gate structure. River was relocated as shown in 1947.

DAM INSPECTION REPORT (Continued) Dam #172 - Pocasset River, Cranston

The granite block abutment wall on right side is becoming heavily overgrown with vines and small vegetation, and this appears to be beginning to affect the alignment of masonry blocks. The discharge channel is becoming slightly overgrown with small weeds and other low vegetation, but this would not currently impede the natural flow of water.

Comments/Recommendations: The dam embankment and spillway appear to be in very good condition. However, it is suggested that the owner put the gate structure back into operable condition, and the gate house made secure. Also, the vines and other vegetation should be removed from the right abutment walls.

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

O.C. w/ LTR TO OWNER AS SUGGESTED PMJ

DAM INSPECTION REPORT

DAM: #172 RIVER: Pocasset River WATERSHED: Pawtuxet/Lower DATE: 30 August 1978

NAME: Cranston Print Works TOWN: Cranston INSPECTED BY: Earle F. Prout, Jr. & Carmine P. Asprinio CPA

OWNER: Cranston Print Works
1381 Cranston Street
Cranston, RI 02920

OTHER INTERESTED PARTY:

REASON FOR INSPECTION: N.P.S.I.D. - Significant/Small Hazard Annual Inspection

* * * * * * * * * *

REPORT:

Current Pool Elevation: full, approx. 1" flowing over spillway crest.

Dam Embankment: Earthen dam embankment, on southerly end of Print Works Pond, is retained on the downstream side by large granite masonry blocks. The crest is flat and mostly clear except for some small scattered brush. The rest of the impoundment is contained by the natural slope of the terrain. There are no signs of erosion along crest or adjacent to massive granite block abutment walls. There are no signs of leakage or seepage.

Gates: (@ raceway) The approach to gate structure is clear and unobstructed, and flowage is controlled by single manually operated gate stand. Water in raceway (photo #6) is currently barely moving.

(@ draw-off) The approach is clear and unobstructed. The trash rack (if any) is under water and not visible. Its condition, however, is of no current consequence because the gate gear mechanism is completely dismantled, making gates currently inoperable. The gears are (or were) of rack and pinion type. The gate structure is constructe of H.M.U. on a granite block foundation, one wall of which has been busted out (photo 4). The granite block foundation appears to be in solid condition. Also, the metal door is currently hanging off its hinges. The outlet structure consists of a 4' steel pipe outle through a massive granite wall emptying into small pool area adjacent to spillway dischar channel.

Spillway: The approach to the spillway is clear and unobstructed of overhanging trees, etc., but heavily overgrown with weeds (photo 2A). It is constructed of large granite blocks with granite monolith slabs, stepped granite face (photos 1 & 2) and small granite slab apron. There are no apparent deficiencies across the crest of the spillway, and the face and apron appear to be in solid, stable condition.

R. I. DEPARTMENT OF PUBLIC WORKS
DIVISION OF HARBORS AND RIVERS

DAM NO. 172

SPECIAL INSPECTION REPORT

INSPECTED BY J. V. KEILY
MF. O. P. SARLE

TOWN - CRANSTON | BROOK
DAM NO 172 NAME CRANSTON PRINT WORKS ON RIVER POCASSET | TRIBR
WATERSHED LOWER PAWTUXET
OWNER Cranston Print Works
ADDRESS 1381 Cranston St., Cranston, R.I. TEL. UN 8800
REPORT ON—NEW CONSTRUCTION REPAIRS INSPECTION ONLY X
PLANS BY APPROVED CONTRACTOR

TICKLER

SPILLWAY
TYPE
CONDITION
DRAW-OFF GATES
NUMBER
CONDITION
TRENCHES & WHEELS
EMBANKMENT
TYPE
CONDITION
APPROACHES
EROSION
BRUSHES & TREES
RIPRAP
PRESENT USE
WHO CONTROLS
WHO CONTACTED AT SITE
INSTRUCTIONS LEFT
IN EMERGENCY CALL

INSPECTION REPORT BY SARLE & KEILY REASON REQUEST DATE 3/17/47

3/17/47

THIS OFFICE WAS NOTIFIED ON A HEAVY LEAK UNDER THE WEST ABUTMENT OF DAM AT THE INTERSECTION OF A NEW WALL WITH OLD ABUTMENT (SEE PLAN 8-3-34). RECORDS OF 1886 SHOW OLD LEAKS IN WEST SIDE. APPARENTLY WATER HAD PERMEATED THE ENTIRE GRAVEL RIDGE ON WEST SIDE, BUT THIS NEW LOW EXCAVATION FOR A NEW WALL HAS ALLOWED WATER TO ESCAPE AT THIS POINT OF LEAST RESISTENCE AND HAS DRIED UP OTHER ESCAPE OUTLETS. AN ATTEMPT WILL BE MADE TO PLUG THIS NEW LEAK TO ALLOW THE CONSTRUCTION OF THE TIE-IN WALL. CERTAIN BLEEDERS WILL BE LEFT IN THE WALL TO FREE IMPOUNDED WATER, AND IT IS QUITE CERTAIN THAT THE WATER LEVEL IN THE WEST ABUTMENT AND ADJOINING AREAS WILL AGAIN RISE. SOME OF THIS WATER HAD PREVIOUSLY ESCAPED THROUGH WALL OF WEST ABUTMENT DIRECTLY BELOW A FOUR-FOOT WASTE PIPE. THIS WILL PROBABLY HAPPEN AGAIN. THE WATER DOES NOT SEEM TO AFFECTED THE STABILITY OF THE WEST ABUTMENT WHICH IS 65 FEET THICK AND INCLOSED IN MASSIVE GRANITE MASONRY. THE COMPANY INTENDS TO TRY TO SEAL OFF THE WATER ON THE UP-STREAM FACE OF THIS ABUTMENT AS SOON AS CONDITIONS ARE FAVORABLE THIS COMING SUMMER. THIS REPORT SIMPLY NOTES CONDITIONS AS THEY WERE OBSERVED BY MR. SARLE AND MR. KEILY TO-DAY.

EMERGENCY CALL:

1. Geo. Casy, Plant Engr., 73 Roslyn Ave., Providence, R.I. Tel. Be 8494
2. Watchman at plant 24 hours each day " Un 8800

APPENDIX B-2

Selected Copies of Past Inspection Reports

1. 17 March, 1947 - Special Inspection Report, R.I. Department of Public Works, Division of Harbors and Rivers.

2. 30 August, 1978 - Dam Inspection Report, R.I. Department of Environmental Management.

APPENDIX B-1

Correspondence pertaining to the history, maintenance, and modifications to the Cranston Print Works Pond Dam as well as copies of past inspection reports are located at:

Department of Environmental Management
State of Rhode Island
83 Park Street
Providence, Rhode Island 02903

APPENDIX B

ENGINEERING DATA

PERIODIC INSPECTION CHECK LIST

PROJECT CRANSTON PRINT WORKS POND DAM DATE _____

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	Raceway in left abutment.
General Condition of stone wall (Granite).	Fair to good.
Rust or Staining on stone wall (Granite)	None observed.
Spalling	Spalling of concrete used to repair some areas of wall.
Erosion or Cavitation	Some gaps in wall.
Cracking	None observed.
Alignment of Monoliths	N/A.
Alignment of Joints	N/A.
Numbering of Monoliths	N/A.

PERIODIC INSPECTION CHECK LIST

PROJECT CRANSTON PRINT WORK POND DAM DATE _____

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Approach to spillway is apparently silted.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Approach Channel	Not observable, underwater.
b. Weir and Training Walls	
General Condition of Granite	Good.
Rust or Staining	Minor, due to weathering.
Spalling	Mortar missing from some joints.
Any Visible Reinforcing	N/A
Any Seepage or Efflorescence	None observed.
Drain Holes	None observed.
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Channel	Gravelly and bouldery.
Other Obstructions	Small trees and bushes growing in channel.

PERIODIC INSPECTION CHECK LIST

PROJECT CRANSTON PRINT WORK POND DAM DATE _____

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Right Outlet. (3'-6" Steel Pipe)
General Condition of Concrete	Fair.
Rust or Staining	Rust staining at three seeps in right wall of downstream channel.
Spalling	Some spalling.
Eorsion or Cavitation	None observed.
Visible Reinforcing	None observed.
Any Seepage or Efflorescence	Three minor seeps in right wall of downstream channel.
Condition at Joints	Fair, some spalling.
Drain holes	None observed.
Channel	Good condition.
Loose Rock or Trees Overhaning Channel.	None.
Condition of Discharge Channel	Trees and bushes growing in channel.

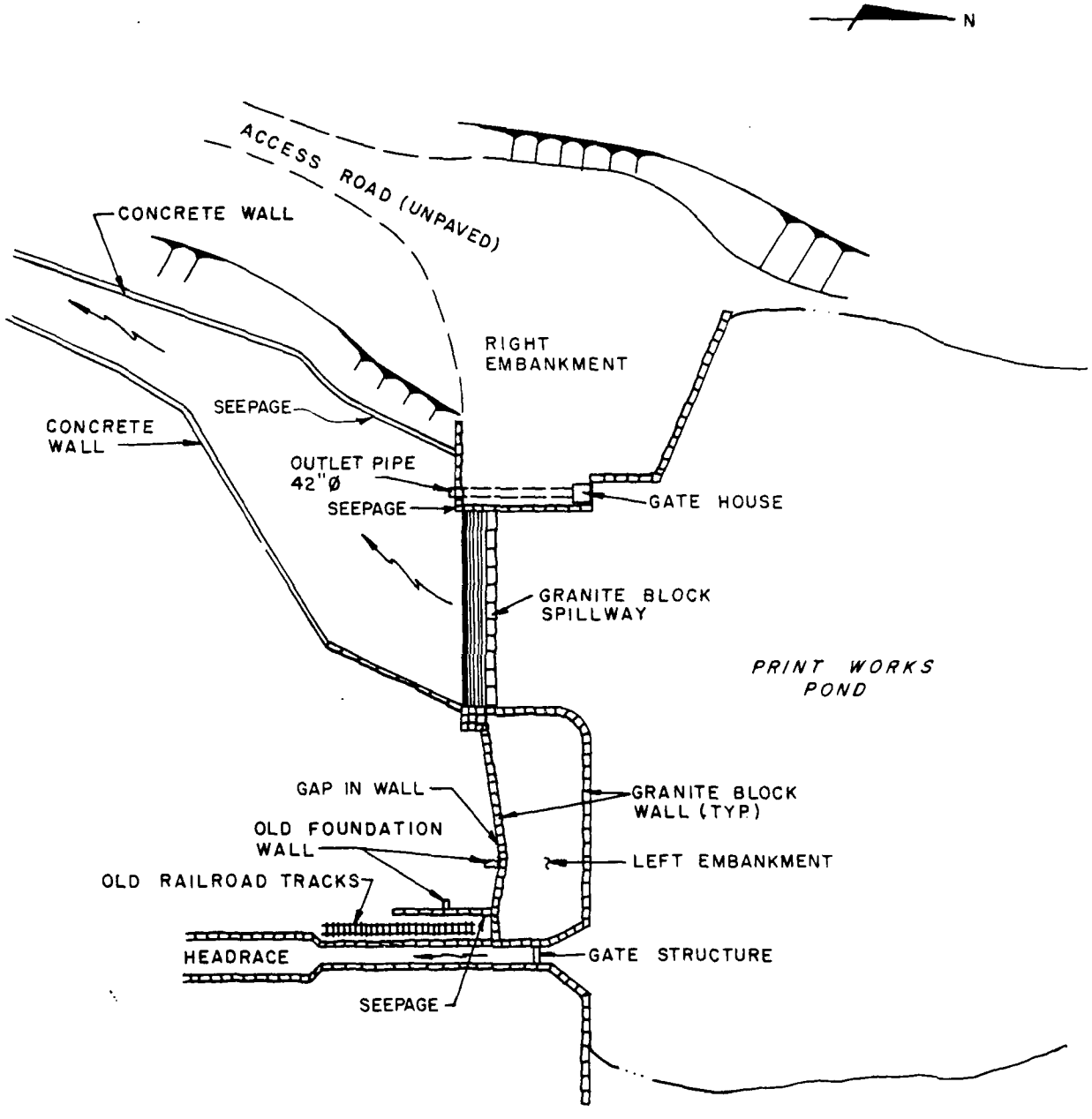
PERIODIC INSPECTION CHECK LIST

PROJECT CRANSTON PRINT WORKS POND DAM DATE _____

INSPECTOR _____ DISCIPLINE _____

INSPECTOR _____ DISCIPLINE _____

AREA EVALUATED	CONDITION	
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Right Outlet (Pipe)	Left Abutment Outlet (Headrace)
a. Approach Channel	N/A	N/A
b. Intake Structure		
Condition of Concrete	Good.	Poor. Severe Spalling.
Stop Logs and Slots	Trash rack in good condition. No stop logs.	None observed.



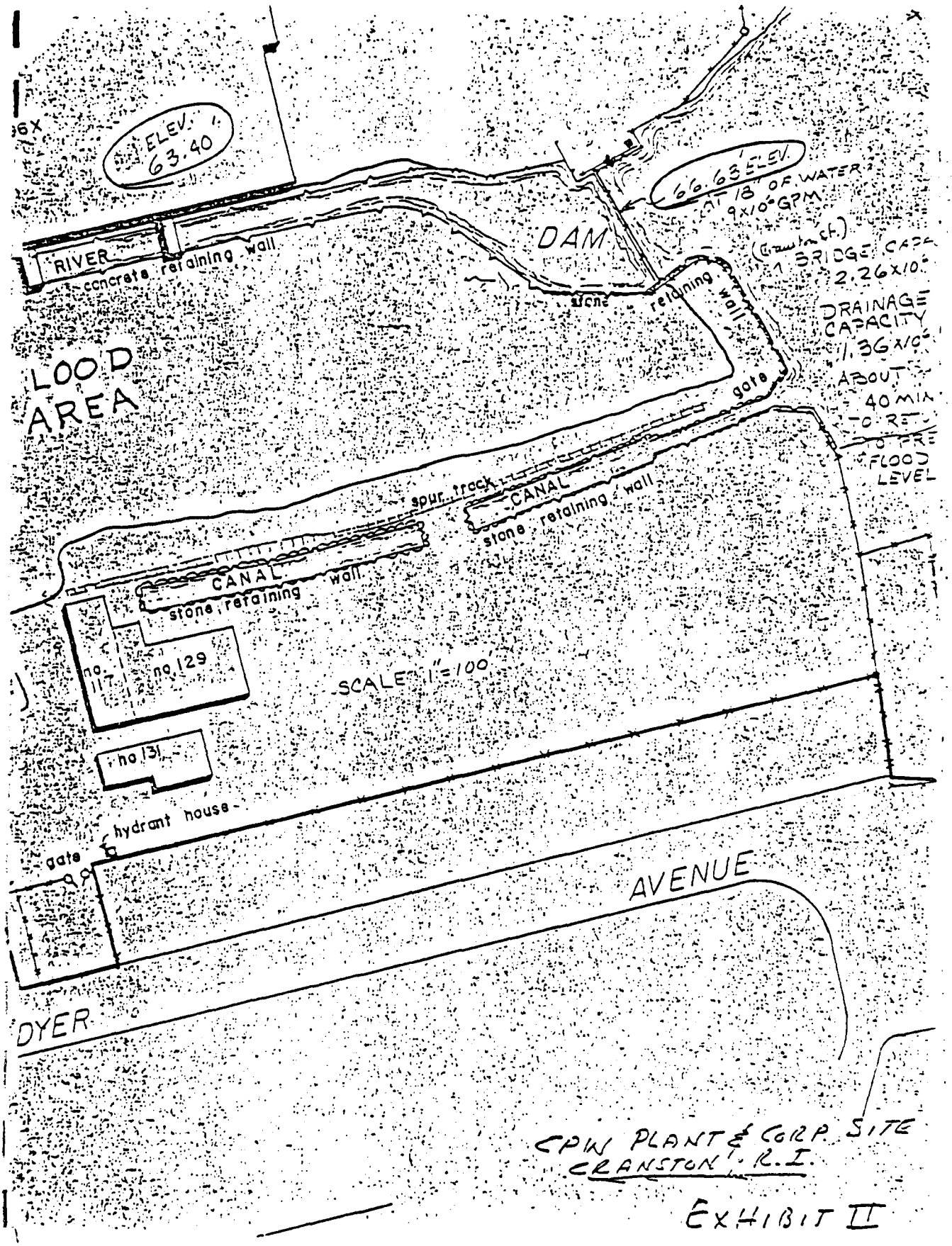
PLAN

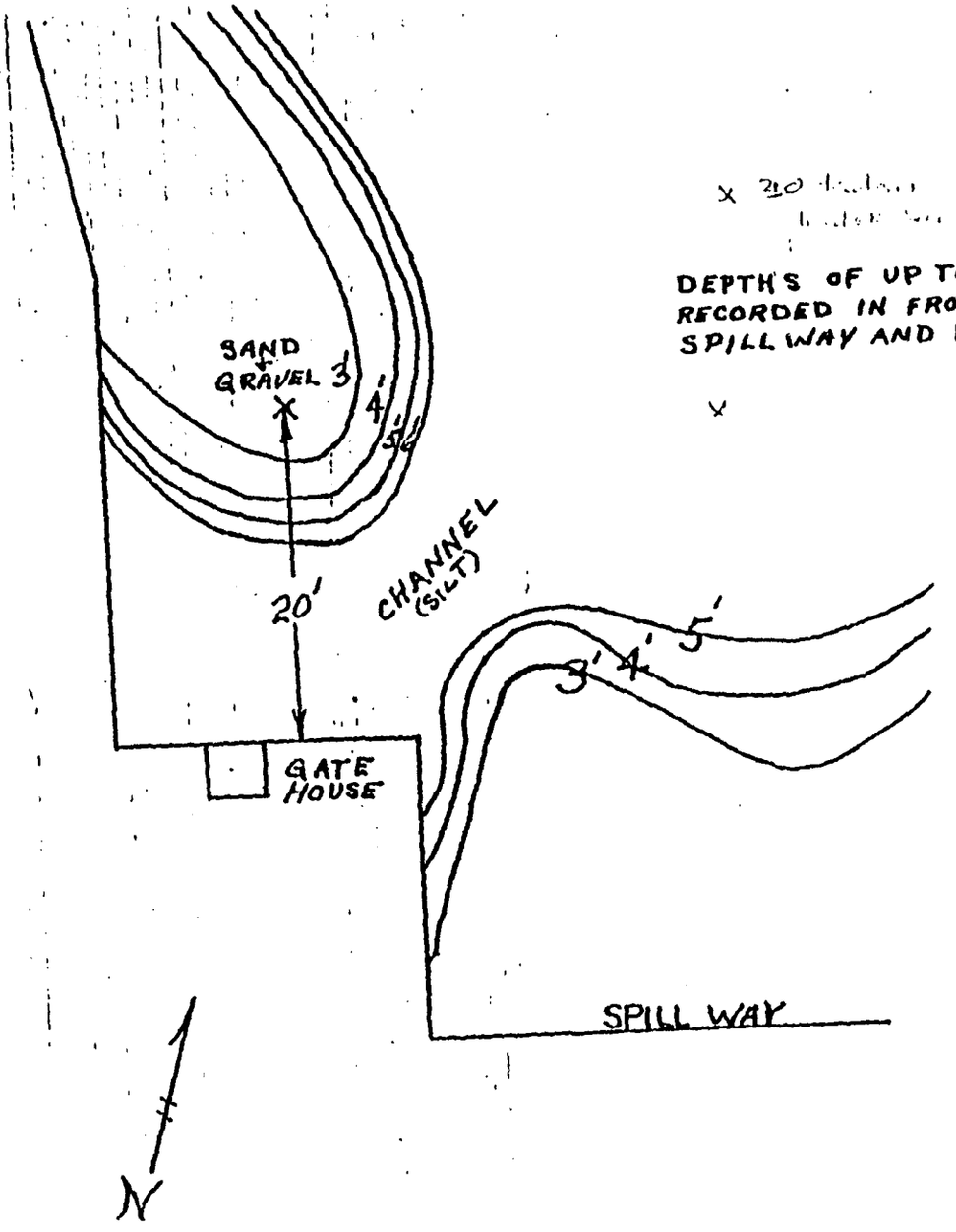
SCALE: 1" = 80'

CRANSTON PRINT WORKS POND DAM
GENERAL PLAN

MAGUIRE
Architects • Engineers • Planners
CE MAGUIRE, INC. Providence, Rhode Island
MARCH 1980

PLATE B

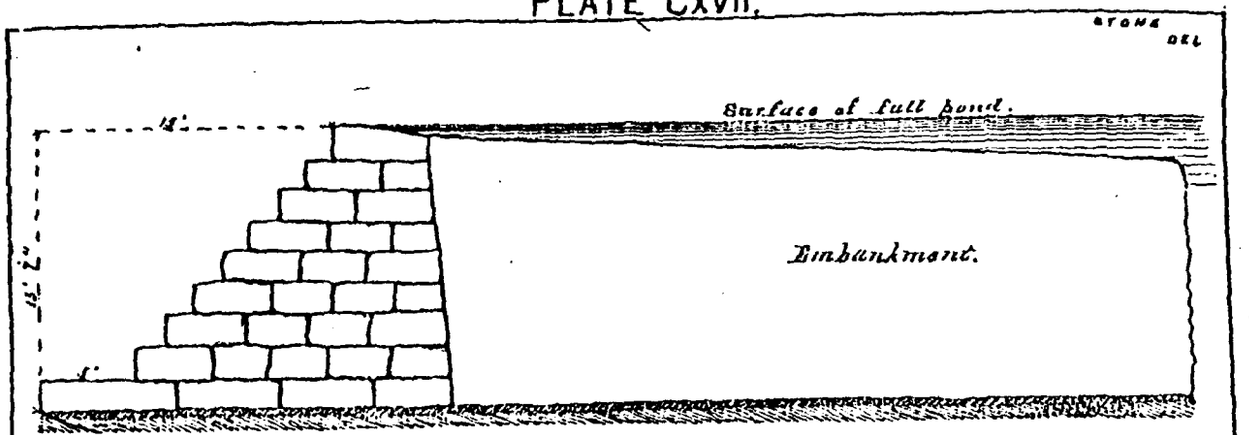

ELEV. 63.40
RIVER
concrete retaining wall
DAM
66.63 ELEV.
AT 18' OF WATER
9X10⁶ GPM
(Granite ch.)
1 BRIDGE CAPA
2.26X10⁶
stone retaining wall
gate
DRAINAGE CAPACITY
1.36X10⁶
ABOUT
40 MIN
TO RE
TO PRE
FLOOD LEVEL
LOOP AREA
spur track
CANAL
stone retaining wall
CANAL
stone retaining wall
no. 117
no. 129
no. 131
SCALE 1"=100'
hydrant house
gate
AVENUE
DYER
CPW PLANT & CORP. SITE
CRANSTON, R.I.
EXHIBIT II



DEPTHS OF UP TO 30' WERE RECORDED IN FRONT OF THE SPILL WAY AND DAM

11-23-77

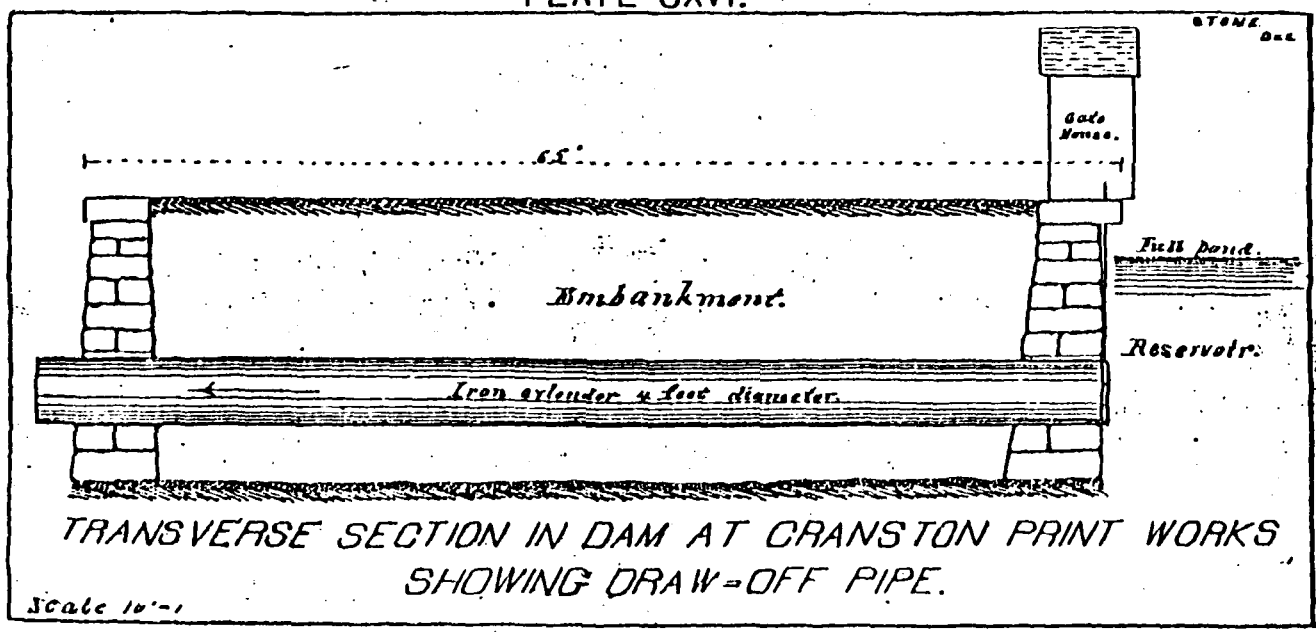
PLATE CXVII.



TRANSVERSE SECTION IN ROLLWAY OF DAM AT CRANSTON PRINT WORKS.

Scale 8'-1"

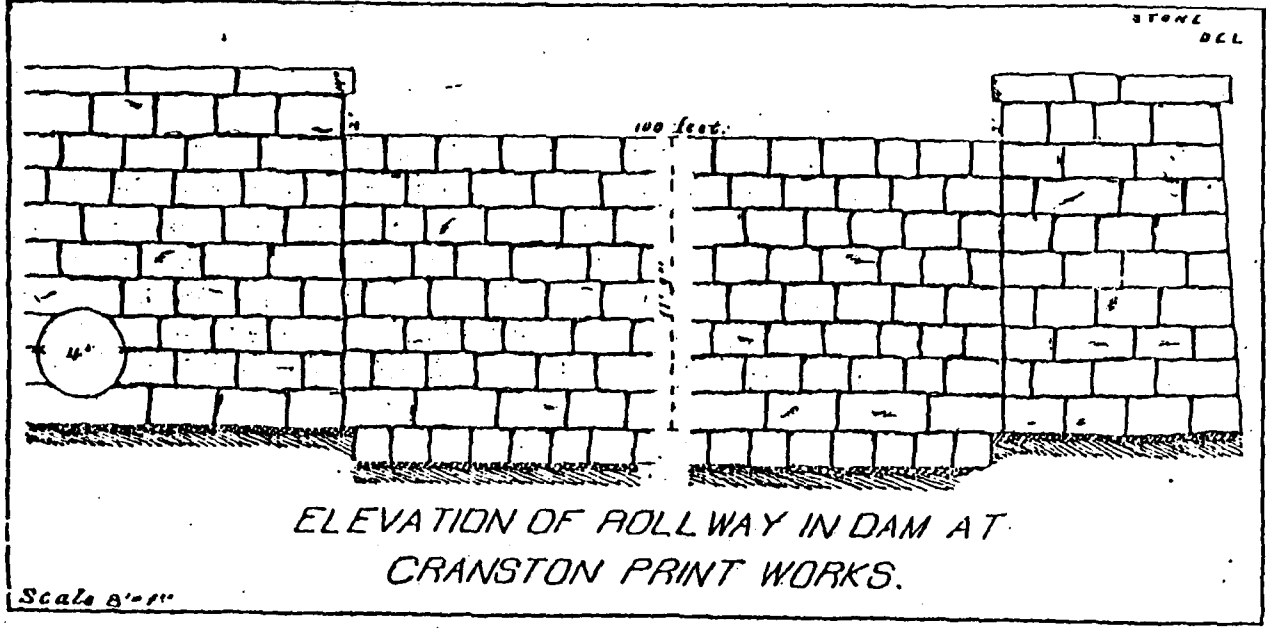
PLATE CXVI.



TRANSVERSE SECTION IN DAM AT CRANSTON PRINT WORKS SHOWING DRAW-OFF PIPE.

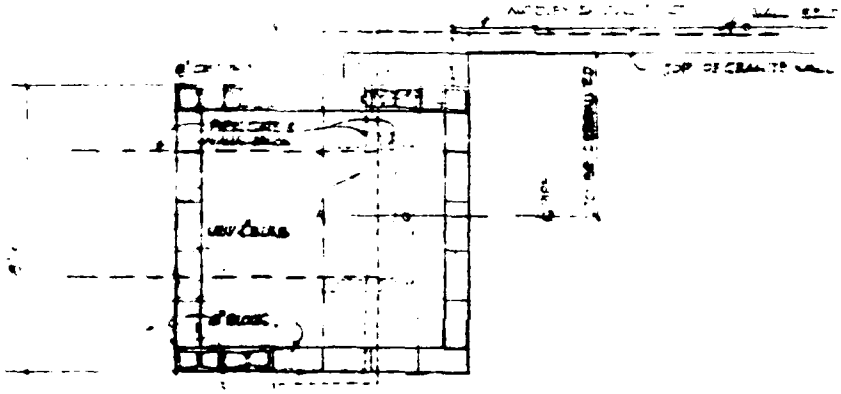
Scale 10'=1

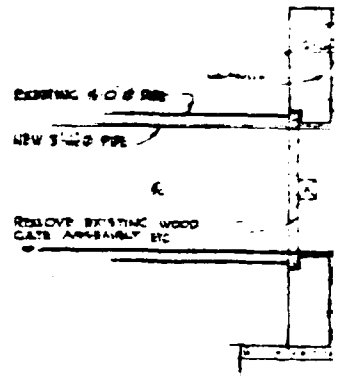
PLATE CXV.



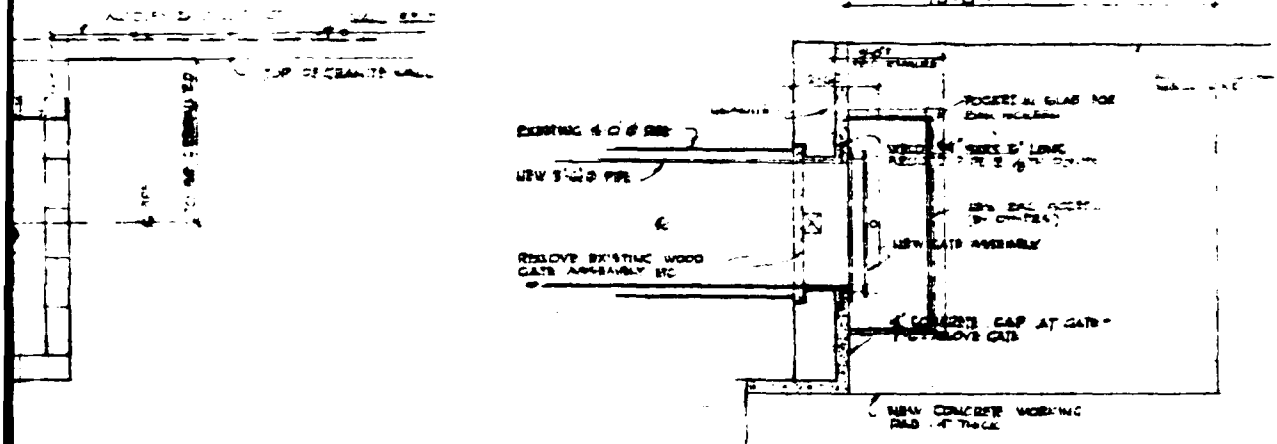
ELEVATION OF ROLLWAY IN DAM AT CRANSTON PRINT WORKS.

Scale 8'=1"


NEW CELLAR
PLAN AT GATE HOUSE


REMOVE EXISTING WOOD
GATE ASSEMBLY ETC
PLAN AT

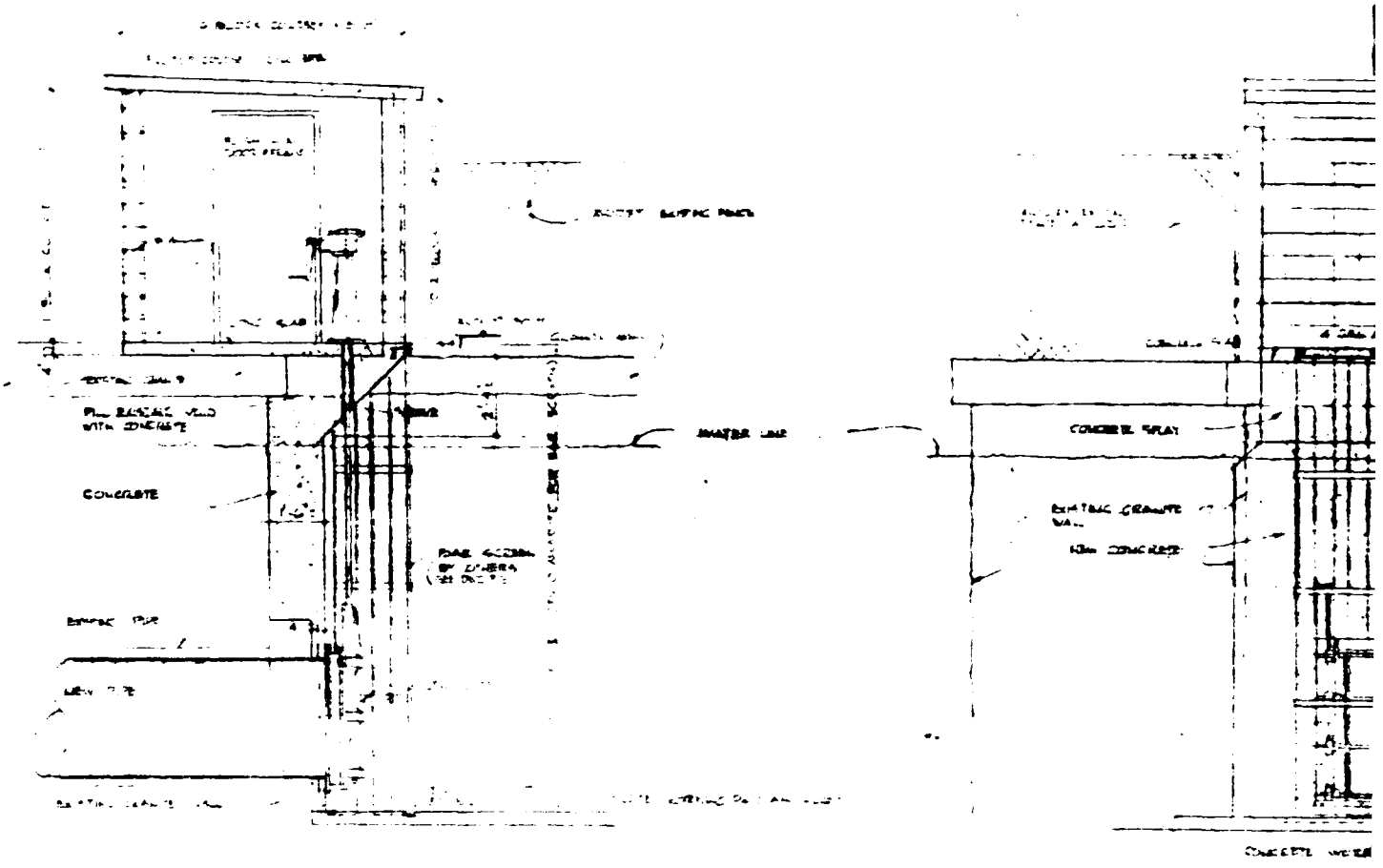
2



PLAN AT D.S.

TO DAM

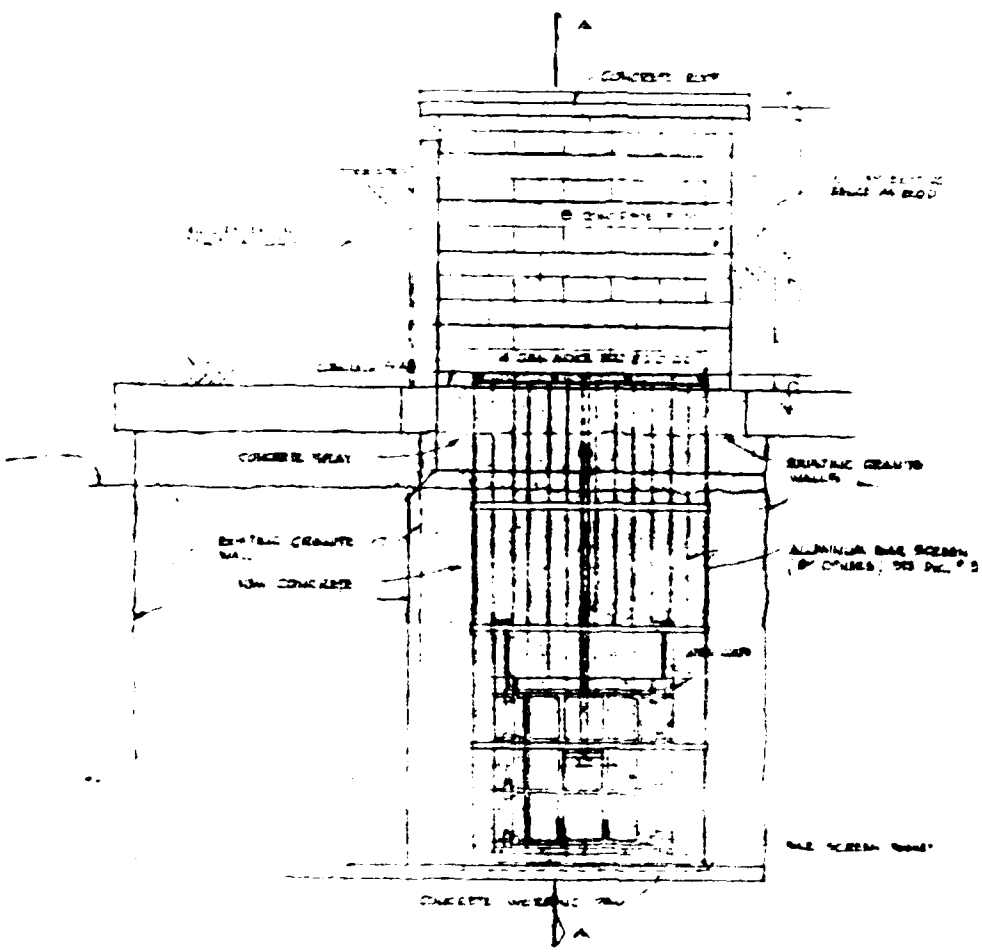
PHOTO REDUCED
NOT TO SCALE



SECTION A-A

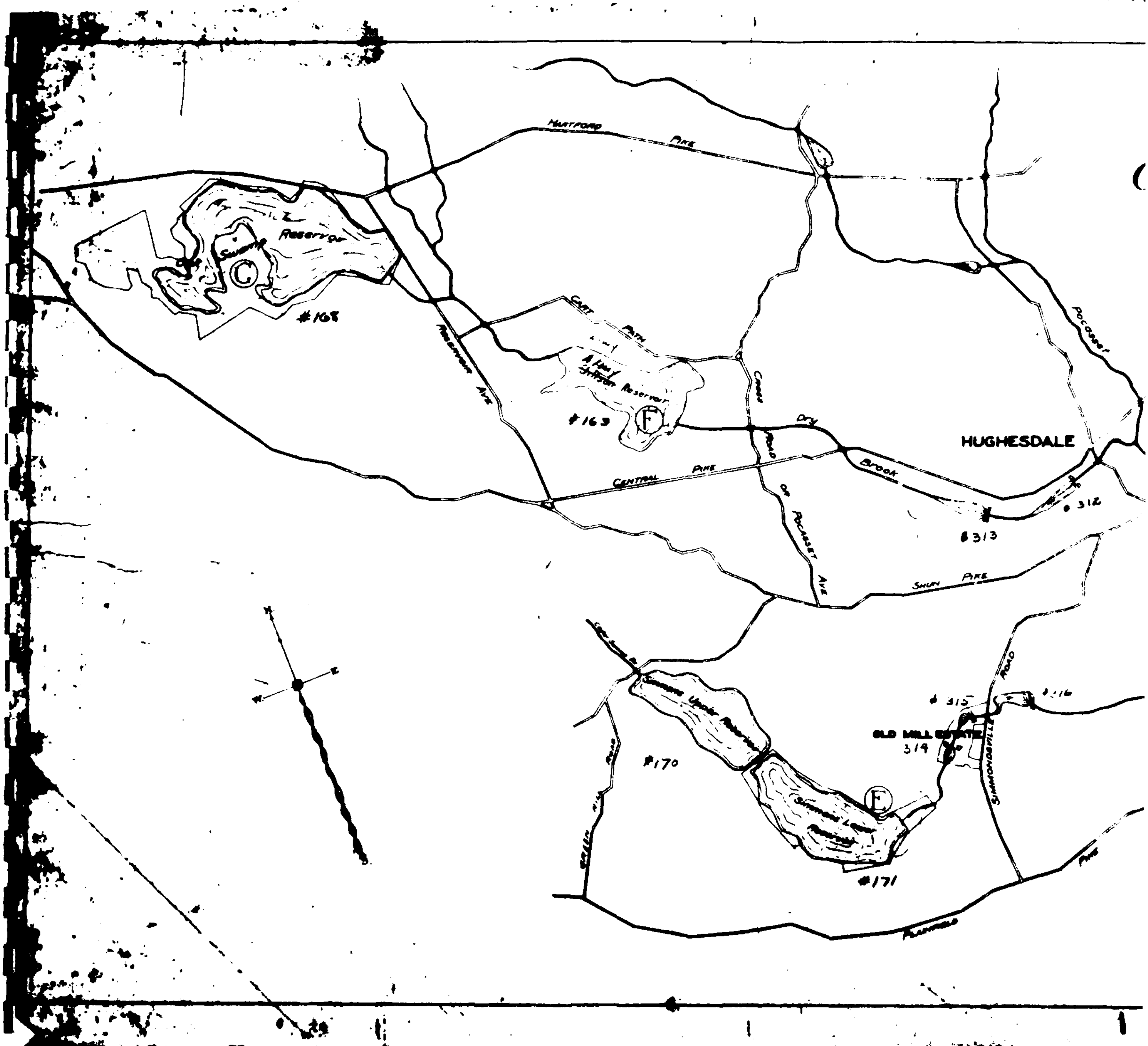
NORTH

2



NORTH ELEVATION

PHOTO REDUCED
NOT TO SCALE

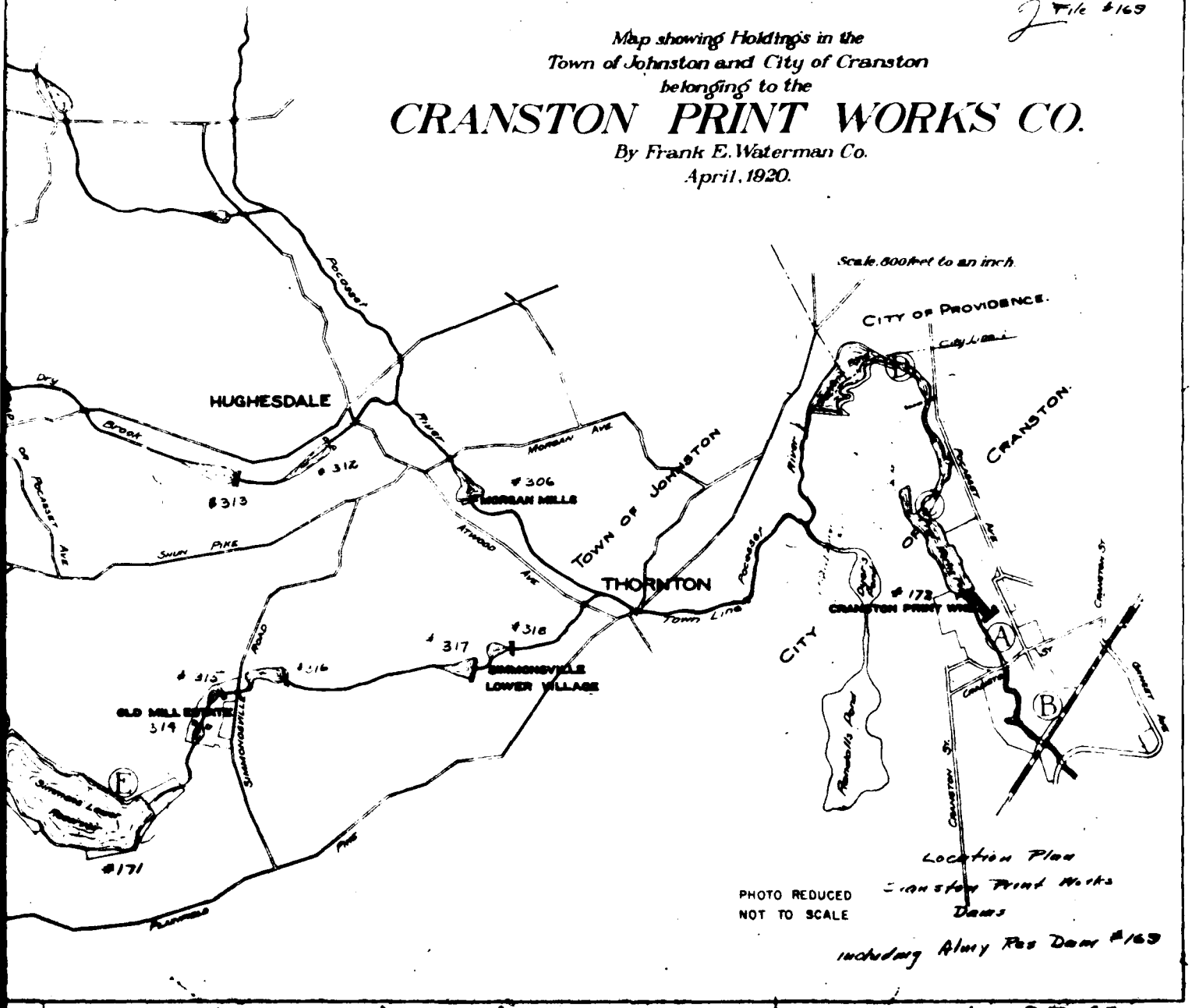

HARTFORD PIKE
Reservoir
#168
CART PATH
RESERVOIR AVE
Simpson Reservoir
#169
Dry Brook
CENTRAL PIKE
HUGHESDALE
POCASSET
#312
#313
SHUN PIKE
OF POCASSET AVE
#170
#171
#315
#316
OLD MILL ESTATE
319
SIMMONSVILLE ROAD
PLAINFIELD
PIKE
HUGHESDALE

File #169

Map showing Holdings in the
Town of Johnston and City of Cranston
belonging to the

CRANSTON PRINT WORKS CO.

By Frank E. Waterman Co.
April, 1920.

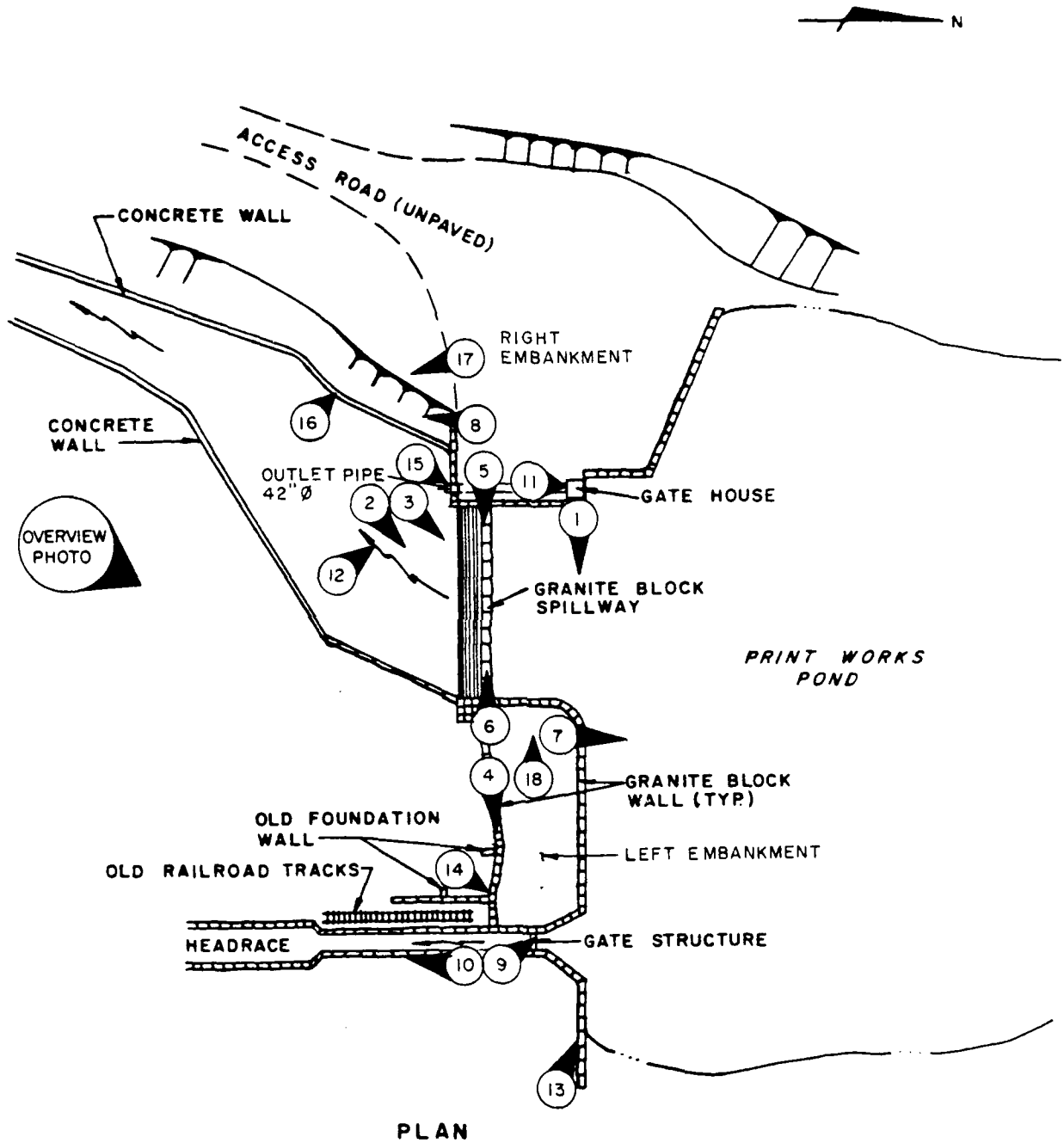


Location Plan
Cranston Print Works
Dams
including Almy Res Dam #169

Plan No 348-65

APPENDIX C

PHOTOGRAPHS



PLAN

SCALE: 1" = 80'

CRANSTON PRINT WORKS POND DAM
PHOTO INDEX

Estimating Maximum Probable Discharges - Inflow and Outflow Values Date of Inspection: November 7, 1979

Name of Dam Cranston Print Works Pond Dam ; Location of Dam Pocassett River ; Town Cranston, R.I.

Watershed Characterization flat; swampy with natural storage areas ; 5.3 sq. miles of drainage area is swampy or occupied by storage reservoirs

Adopted "test" flood = PMF = CSM = CFS; Re = Effective Rainfall = 19.0 inches

D.A. Drainage Area (Gross) = 17.60 Square Miles; Basin Slope = 0.03± hence; flat

S.A. = Surface Area of Reservoir = 0.039 Square Miles; Time of Concentration larger than 120 minutes

Shape and Type of Spillway = overflow - vertical stepped-stone crested weir

B = Width of Spillway = 100 feet; C = Coefficient of Discharge = (3.33-Friction) = 3.30

Maximum Capacity of Spillway Without Overtopping = 1715 CFS = 13.8 % of test flood

Top of Dam Elevation = 69.63 ; Spillway Crest Elevation = 66.63

Overflow portion of Length of Dam = 320 ; C = Coefficient of discharge for Dam = 3.00

Name of Dam	Test Flood Q_p CSM	Test Flood Q_p CFS	Inflow Characteristics h_0 in feet	Inflow Characteristics S_0 in in.	Outflow Characteristics First Approximation Q_{p1} CFS	h_1 in ft.	S_1 in in.	Outflow Characteristics Second Approximation S_2 in in.	h_2 in ft.	Q_{p2} CFS	Outflow Characteristics Third Approximation (Adopted) S_3 in in.	h_3 in ft.	Q_{p3} CFS
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Cranston Print Works Pond Dam	PMF = 770	13520	-	-	Storage in the reservoir is almost negligible due to small surface area.						0.10	8.16	6715
	½PMF = 385	6760	-	-							0.10	6.43	12400

Q_p = Discharge; h = Surcharge Height; S = Storage in Inches

NOTE: Outflow discharge values are computed as per COE guidelines.

A. Size Classification — Cranston Print Works Pond Dam

Height of dam = 19.0 ft.; hence SMALL

Storage capacity at top of dam (elev. 69.63) = 255 AC-FT.; hence SMALL

Adopted size classification SMALL

B. Hazard Potential

The dam is classified as a HIGH hazard structure because its failure may result in the loss of more than a few lives, property damage to 6 to 10 industrial buildings including office equipment, machinery, and inventories, and damage from flooding to 10 to 15 dwellings in the Highland Park area. Cranston Street and several residential streets, including the overhead utilities within the rights of way,will also experience flooding and damage.

C. Adopted Classifications

HAZARD	SIZE	TEST FLOOD RANGE
HIGH	SMALL	Half PMF to Full PMF

Adopted Test Flood = Full PMF =	770	CSM
=	13520	CFS

D. Overtopping Potential

Drainage Area =	17.60	sq. miles
Spillway crest elevation =	66.63	NGVD
Top of Dam Elevation =	69.63	NGVD
Maximum spillway discharge Capacity without overtopping of dam =	1715	CFS
"test flood" inflow discharge =	13520	CFS
"test flood" outflow discharge =	12400	CFS
% of "test flood" overflow carried by spillway without overtopping =	13.8%	
"test flood" outflow discharge portion which overflows over the dam =	10685	CFS
% of test flood which overflows over the dam =	86.2%	

CRANSTON PRINT WORKS POND DAM
DRAINAGE BASIN

Datum: NGVD
Scale: Graphic
Drainage Area: 17.6 sq. mi.
USGS Quadrangle Sheets:
No. Scituate, RI - Crompton, RI
Providence, RI - E. Greenwich, RI

PLATE D-1


LIMIT OF DRAINAGE BASIN
LIMIT OF IMPACT AREA
½
0
1 MILE

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

PHOTO C-17 Errosion on the crest and downstream face at the right dam embankment.

PHOTO C-18 Small trees and brush on crest of left dam embankment.

PHOTO C-15 Seepage at outlet works conduit.

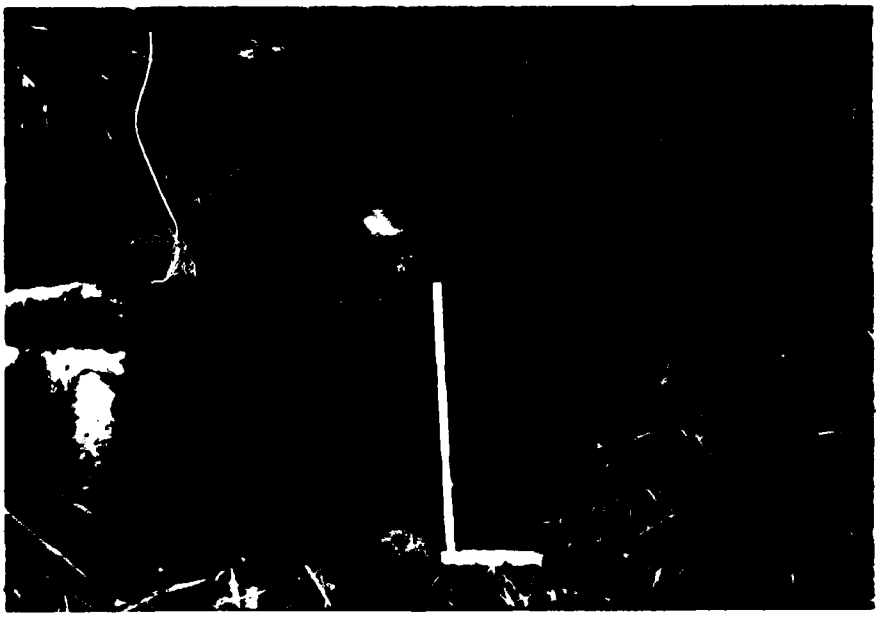


PHOTO C-16 Seepage through right downstream channel training wall.

PHOTO C-13 Misaligned and dislodged retaining wall on upstream face from left abutment area.

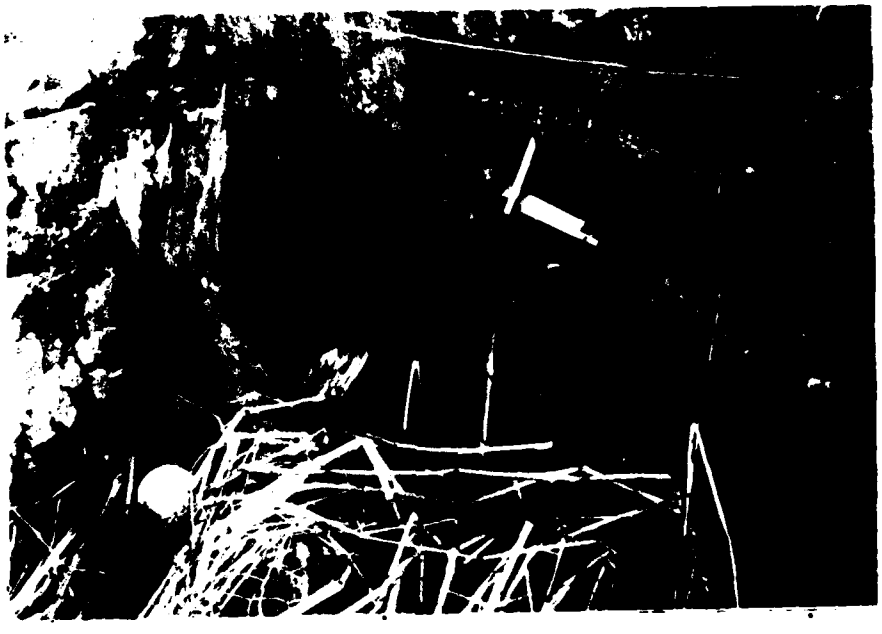


PHOTO C-14 Seepage at the downstream junction of the headrace retaining wall and dam retaining wall.

PHOTO C-11 Sluice gate control mechanism for outlet works at right abutment.

PHOTO C-12 Right abutment of dam and outlet works' conduit.

PHOTO C-9 Headrace control gate looking toward reservoir.

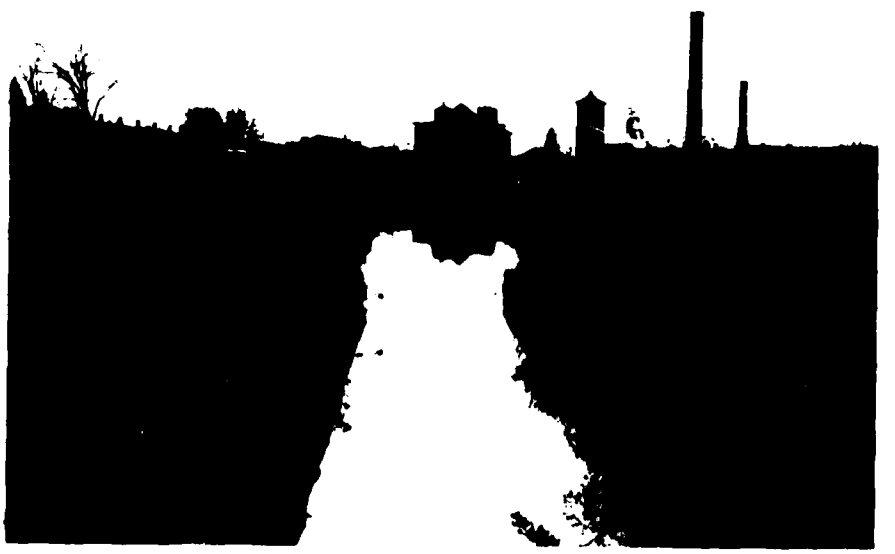


PHOTO C-10 Headrace looking downstream from dam.

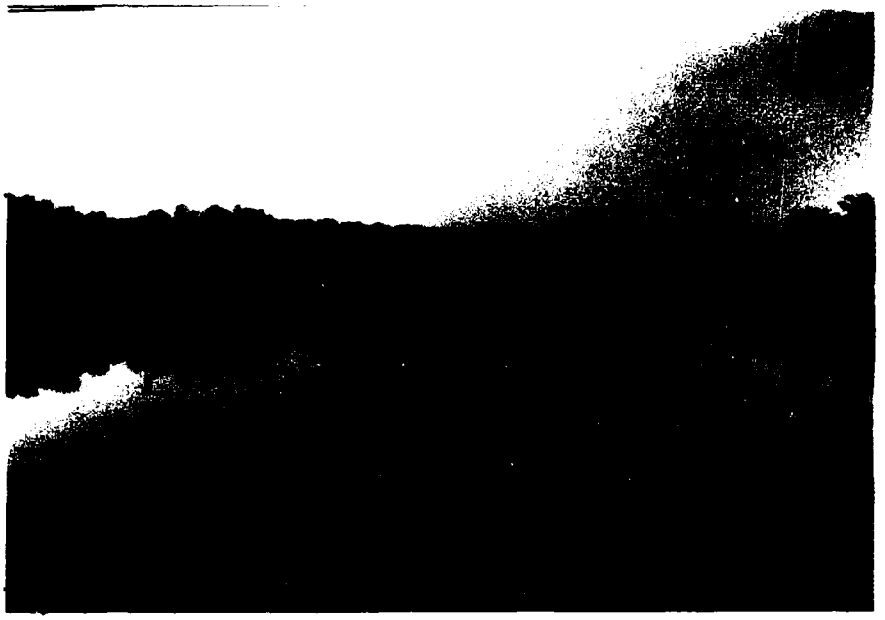


PHOTO C-7 View of reservoir from dam.

PHOTO C-8 Downstream channel below dam from toe of dam.

PHOTO C-5 Spillway crest looking from right abutment.

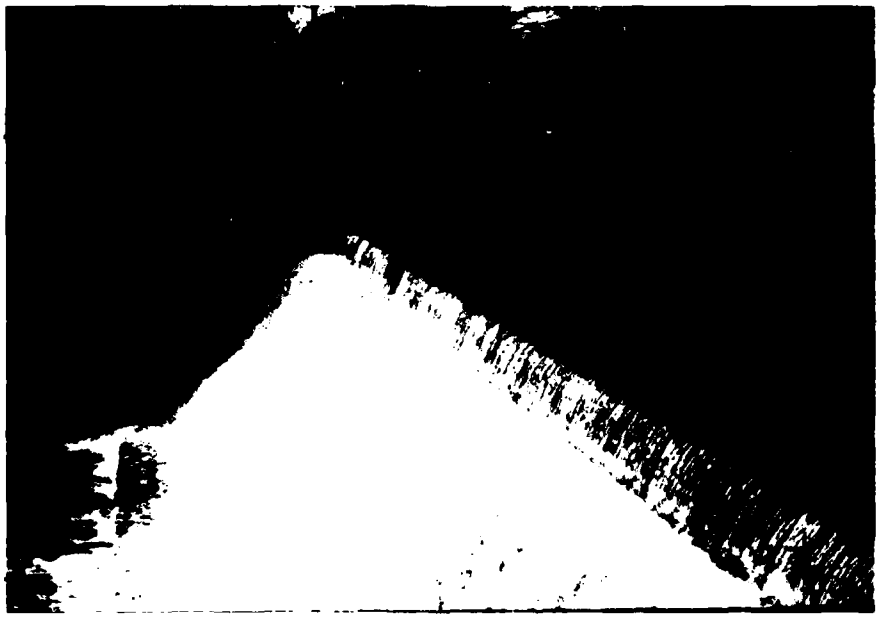


PHOTO C-6 Spillway crest looking from left abutment.

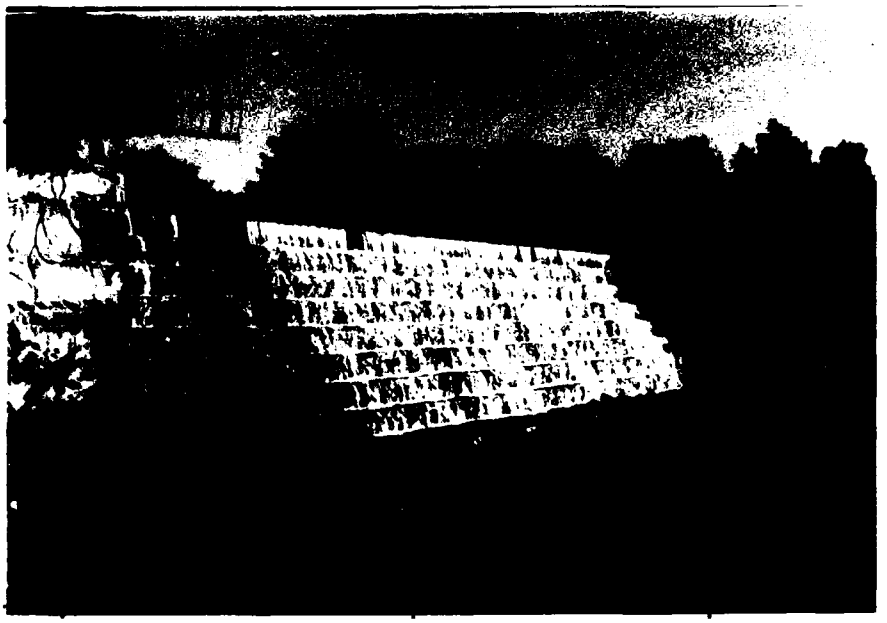


PHOTO C-3 Downstream face of overflow spillway.

PHOTO C-4 A portion of dam crest from left spillway abutment.

PHOTO C-1 Upstream face of dam looking from right abutment area.

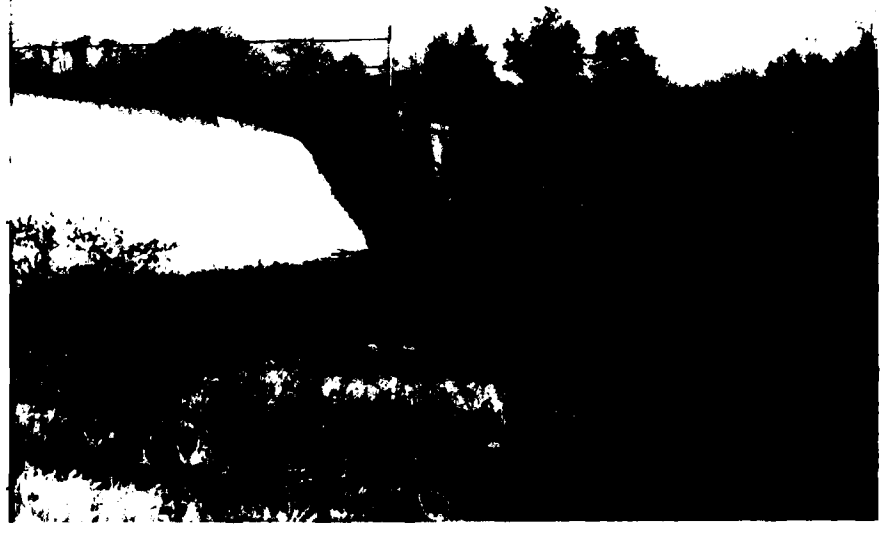


PHOTO C-2 Downstream face of dam looking from right side of discharge channel.

Name of Dam: Cranston Print Works Pond Dam

Estimating Effect of Surcharge Storage on "Test Flood"
[Routing of Flood Through Reservoir]

The routing of floods through the reservoir was carried out according to guidelines established by the Corps of Engineers in Phase-1 Dam Safety Investigations issued March, 1978.

Formulae used were the following for peak inflow = Q_{p1} in C.F.S.

Surcharge height to pass Q_{p1} in feet = $h_1 = \left[\frac{Q_{p1}}{CB}\right]^{2/3}$ ----------(1)

Surcharge storage in inches for surcharge height h_1 = $S_1 = \frac{S.A \times h_1 \times 12}{D.A}$ ---(2)
where S.A = surface area in square miles
where D.A = drainage area in square miles

$$Q_{p2} = Q_{p1}\left[1 - \frac{S_1}{\text{Total Effective Rainfall}}\right] \text{----------(3)}$$

First Approximation

Test flood inflow = Full PMF = Q_{p1} = 13520 C.F.S.

h_1 = 8.50 feet

S_1 = 0.12 inches

Final Approximation

Test flood outflow = Q_{pfinal} = 12400 C.F.S.

h_{final} = 8.16 feet

S_{final} = 0.10 inches

In this final approximation, equations (1), (2) and (3) are satisfied by trial and error with total effective rainfall equal to 19.0 inches.

"Rule of Thumb Guidance for Estimating Downstream Dam Failure Discharge"

BASIC DATA

Name of dam Cranston Print Works Pond Dam Name of town Cranston, R.I.

Drainage area = 17.60 sq. mi., Top of dam 69.63 NGVD

Spillway type = overflow; stepped weir Crest of spillway 66.63 NGVD

Surface area at crest elevation = 0.039 sq. mi. = 25 acres

Reservoir bottom near dam = 54.31 NGVD

Assumed side slopes of embankments 2:1

Depth of reservoir at dam site 15.32 = y_o = 15.0 ft.

Mid-height elevation of dam = 74.13 NGVD

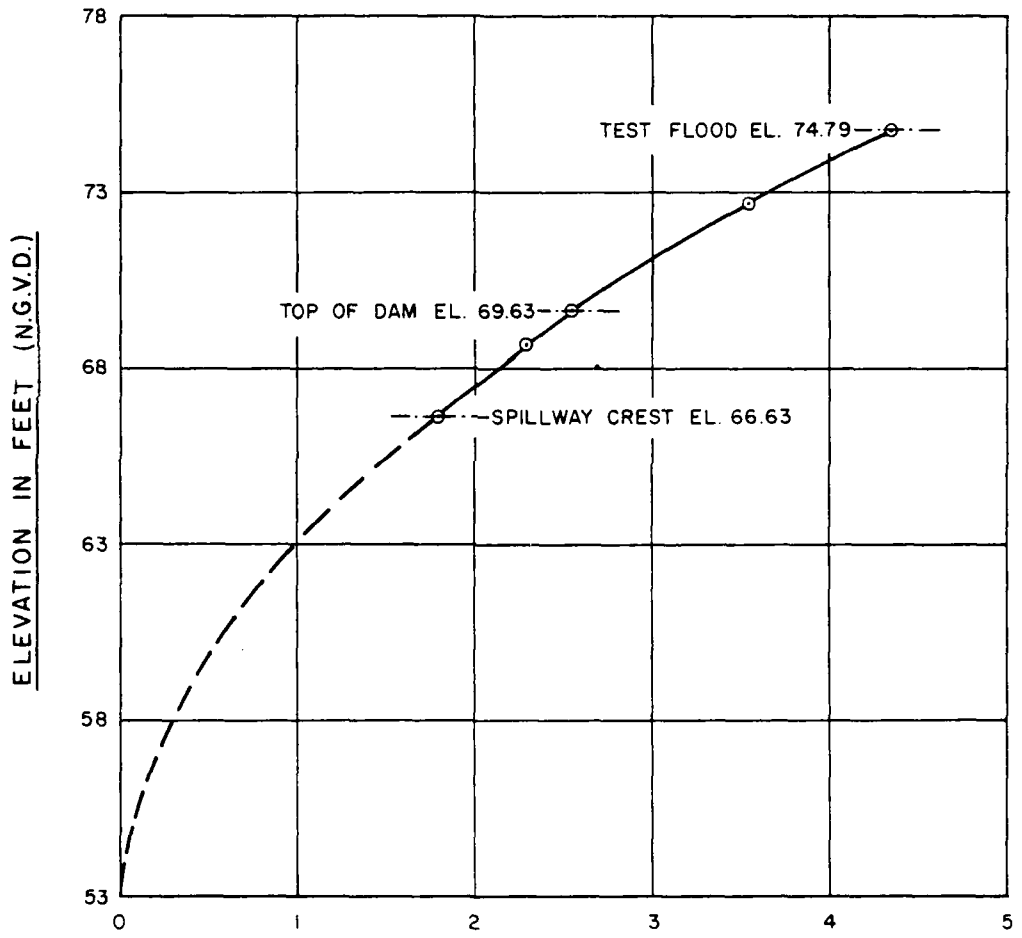
Length of dam at crest = 320 feet

Length of dam at mid-height = 260 feet

6.4% of dam length at mid-height = W_b = 16.50 feet

Width of channel immediately downstream = B = 100 ft.; Shape of Breach = rectangular

Elevation (NGVD)	Estimated Storage in AC-FT	
55.0	30	Assumed values
60.0	70	
65.0	140	
66.63	180	Spillway crest elevation
68.63	230	
69.63	255	Top of dam elevation
72.63	355	
74.79	435	Test flood elevation



STORAGE-ELEVATION CURVE

CRANSTON PRINT WORKS POND DAM

PLATE D-6

DAM FAILURE ANALYSIS

In addition to energy considerations, the volume of water which is available in the reservoir to sustain the flood wave must be considered. Important energy losses which occur as the flood wave moves downstream include friction losses, bend losses, obstruction losses, expansion and contraction losses, etc. Also the failure discharge and energy losses are reduced by the failure hydrograph being modified with decreasing peak due to available storages downstream. Judgment was used to estimate the most critical situation after the dam failure. Consequently analysis was based upon i) undular wave rather than hydraulic bore; ii) impact of flood wave and the resulting energy loss due to damaged or destroyed structures and sinuosity of the channel were ignored; and iii) the dam failure discharge of 2538 C.F.S. will merge with 1715 C.F.S. already flowing through the existing overflow spillway making a total outflow of 4253 C.F.S. It is assumed that prior to failure, the maximum spillway discharge has already substantially filled the available storage areas downstream. In this case large storage areas are not available and no adjustment of outflow discharge is required. At a distance of 2000 feet downstream the Cranston Street Bridge _____ obstruction will not allow this large discharge to go through and ponding against this obstruction will convert its wave and kinetic energy back into pressure energy and flow changing to steady and uniform flow with 8.6ft depth following Manning's formula.

NOTE: --

1. Adopted water surface elevation is higher of the two values:
   a) ground elevation + $\frac{4}{9} y_o$ - drop in depth

   OR b) ground elevation + d_n
2. There are three depths for different characteristics of flow.
   a) Depth of flow immediately downstream of dam for unsteady flow conditions = $\frac{4}{9} y_o$ = 6.70 feet
   b) Normal depth for $Q = Q_b + Q_S$ value of discharge = d_n = 8.60 feet
   c) Normal depth for $Q_S = d_n^1$ = 5.0 feet
3. Maximum depth is greater of $\frac{4}{9} y_o$ or d_n = 8.60 feet

   Maximum velocity of flow = $\frac{4}{3}\sqrt{gy_o}$ = 2.93 ft./sec.

   Increase in depth due to failure = (d_n or $\frac{4}{9} y_o$) - d^1 n = 3.60 feet

DAM FAILURE ANALYSIS

NOTES:
1. $W_B \leq B$
2. Failure of dam is assumed to be instantaneous when pool reaches top of dam, and is a full depth - partial width rectangular shaped failure.

STEP 1 - Dam Failure Discharge = Q_b

$$Q_b = \frac{8}{27} W_B \sqrt{g}\ y_o^{3/2} \left(\frac{B}{W_B}\right)^{0.25*} = 1.68\ B^{0.25}\ W_B^{0.75}\ y_o^{1.5}$$

$$= 2538 \text{ C.F.S.}$$

* Reference: Research note No. 5, "Guidelines for Calculating and Routing a Dam - Break Flood by the Hydrologic Engineering Center - C.O.E. - January, 1977.

Maximum Spillway Discharge = Q_S = 1715 C.F.S.
(C = 3.30 B = 100 H = 3.00 ft.)

STEP 2 - Wave Flow (Unsteady Flow) Characteristics

Depth of flow immediately downstream of Dam = $\frac{4}{9} y_o$ = 6.66 ft. = 6.7 feet

Velocity of flow immediately downstream of Dam = $\frac{2}{3} \sqrt{gy_o}$

= 14.65 ft./sec.

STEP 3 - Adopted minimum possible depth of flow = $0.138\ y_o$ = 2.07 ft.
Actual maximum possible velocity of flow = $2\sqrt{gy_o}$ = 44.0 ft./sec.
Adopted theoretical maximum possible velocity = $\frac{2}{3}\ 2\sqrt{gy_o}$ = 29.30 ft./sec.

STEP 4 - Normal Flow (typical) Manning's Characteristics

Location of unwashable major obstruction Cranston Street Bridge
2000 = ft. D/S

S_o = 0.002 ; "n" = 0.05 ; Bed width of channel = b = varies
Total failure discharge = $Q = Q_b + Q_S$ = 4253 C.F.S.
Normal depth of flow for Q (4253 C.F.S.) = 8.6 feet = d_n
Normal depth of flow for Q (1715 C.F.S.) = 5.0 feet = d_n^1
Adopted maximum depth is larger of $\frac{4}{9} y_o$ or d_n = 8.6 feet
Adopted increase in depth due to failure of dam ($\frac{4}{9} y_o$ or d_n) - d_n^1 = 3.6 feet
Adopted maximum velocity of flow = $\frac{4}{3}\sqrt{gy_o}$ = 29.3 ft./sec.

DAM FAILURE ANALYSIS

STEP 5 -

Anticipated adopted minimum wave depth of flow = $d_{minimum}$
= 0.17 y_o feet = 2.55 feet

Parabolic shaped water surface profile from the dam upto obstruction presumably unwashable 2000 ft. (x_{total}) ft. downstream is computed by and adjusted for possible steady and normal flow depth backup in the below given table.

$$(\frac{4}{9} y_o - d_{min.}) (\frac{x}{x_{total}})^2 = 0.28\ y_o (\frac{x}{x_{total}})^2 \text{ where } x_{total} = 2000 \text{ ft.}$$

Distance from center line of dam = x	$(\frac{x}{x_{total}})^2$	Drop in depth	Water Surface Elevation as Unsteady Flow	Ground Elevation	Normal Depth	Adopted Water Surface Elevation
0	0	0	69.63= Top of dam	--		69.63=Top of dam
0	0	$\frac{5}{9} y_o$ = 8.3 ft.	Adopt 62.80	54.60	dn	61.33= just D; Adopt 62.80
200	0.01	0.04	60.90	54.2	8.6	62.8
400	0.04	0.17	60.30	53.8	8.6	62.4
600	0.09	0.38	59.40	53.4	8.6	62.0
800	0.16	0.67	59.00	53.0	8.6	61.6
1000	0.25	1.05	58.30	52.6	8.6	61.2
1200	0.36	1.51	57.70	52.2	8.6	60.8
1400	0.49	2.06	56.50	51.8	8.6	60.4
1600	0.64	2.69	55.40	51.4	8.6	60.0
1800	0.81	3.40	54.30	51.0	8.6	59.6
2000	1.00	4.20	53.10	50.6	8.6	59.2

Note: Adopted water surface elevation is higher of the two values:

a) Ground Elevation + $\frac{4}{9} y_o$ = drop in depth

OR b) Ground Elevation + d_n

CRANSTON PRINT WORKS POND DAM

COMPUTATIONS FOR
SPILLWAY RATING CURVE AND
OUTLET RATING CURVE COMPUTATIONS

Spillway width = 100 feet; Spillway crest elevation = 66.63 NGVD

Length of dam = 320 feet; Top of dam elevation = 69.63 NGVD

C = 3.3 for spillway; 3.0 for the dam.

i) SPILLWAY RATING CURVE COMPUTATIONS

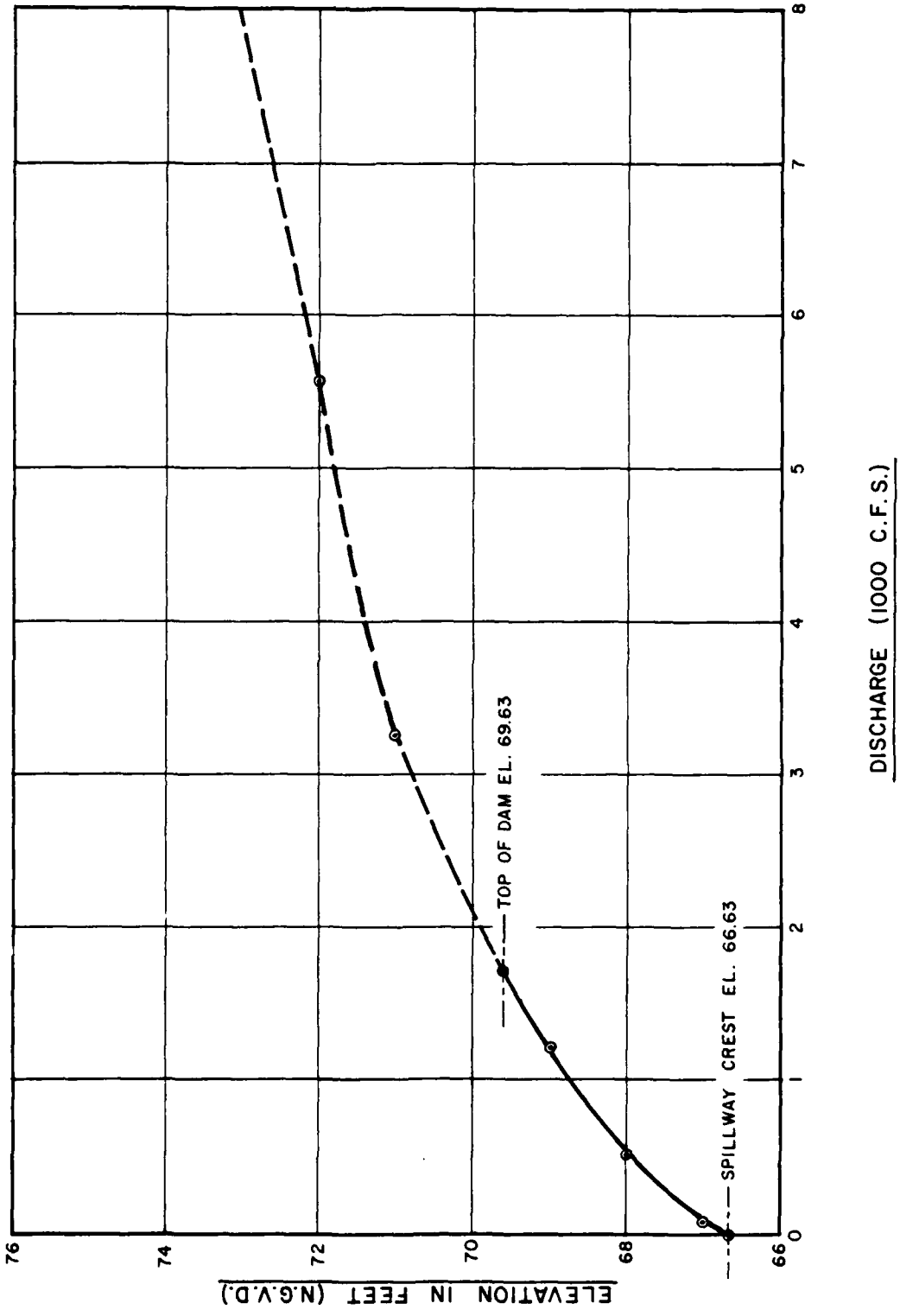
Elevation (ft.) NGVD	Spillway Discharge (CFS)	Remarks
66.63	0	Spillway Crest - Elevation
67.00	74	
68.00	329	
69.00	1204	
69.63	1715	Top of Dam Elev.
71.00	3254	
72.00	5568	
74.79	12400	Test Flood Elev.

ii) OUTLET RATING CURVE COMPUTATIONS

Elevation (ft.) NGVD	Discharge (CFS)	Remarks
54.31	0	Invert of outlet Elev.
56.00		Centerline of outlet Elev.
58.00	69.70	
60.00	98.50	
62.00	120.70	
64.60	139.40	
66.63	160.60	Spillway Crest Elev.
69.63	181.90	Top of Dam Elev.
71.00	190.80	
73.00	203.10	
74.79	219.20	Test Flood Elev.

Size of outlet = 42" dia. C.I. Pipe
Area of outlet = 9.6 sq. ft.

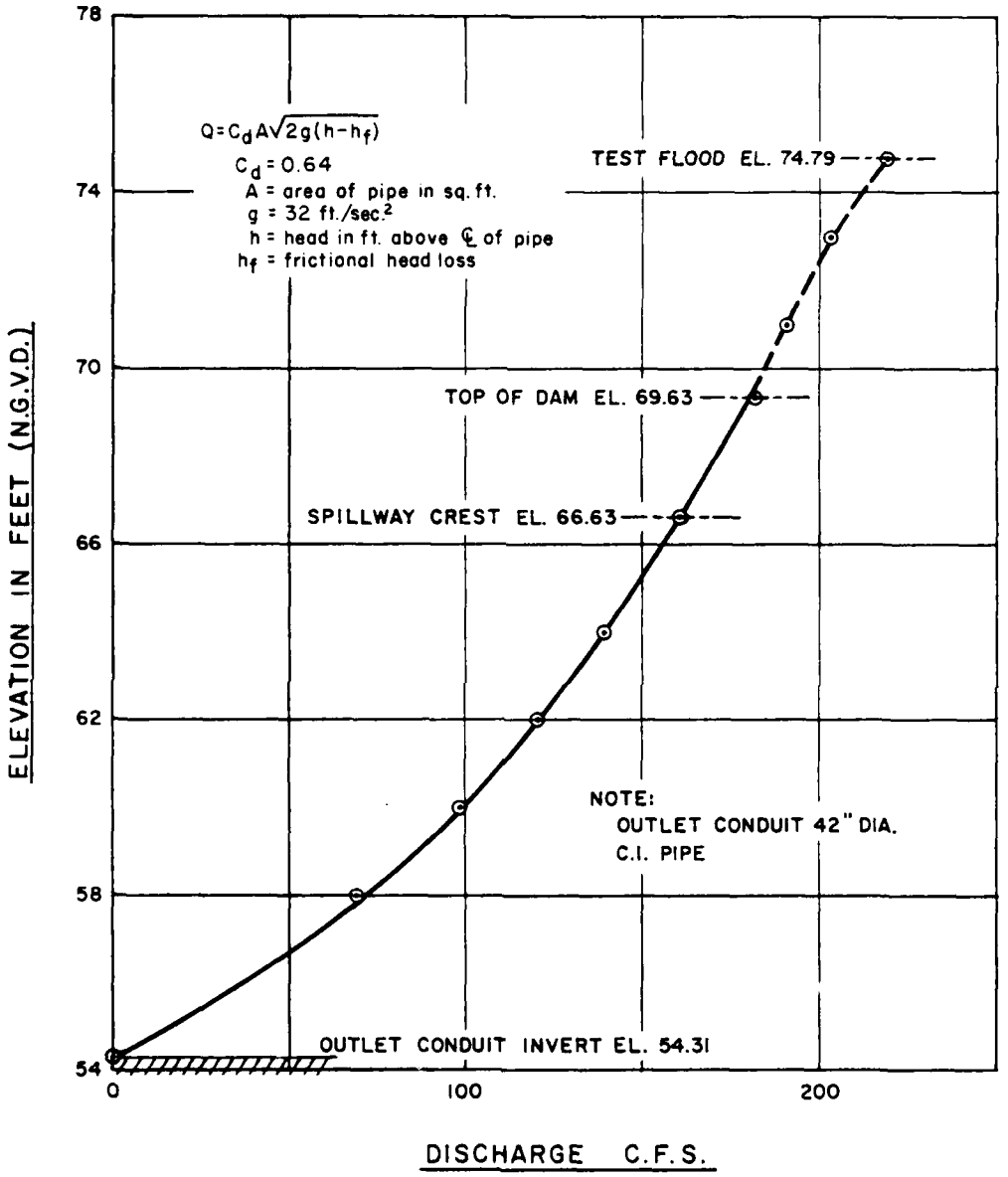
Invert of outlet = 54.31
Center line of outlet = 56.06



SPILLWAY RATING CURVE

CRANSTON PRINT WORKS PONDS DAM

PLATE D-11



OUTLET RATING CURVE

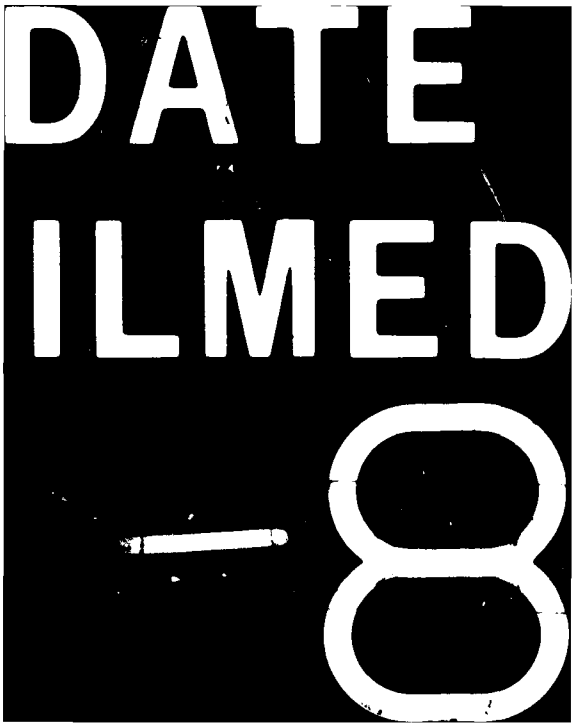
CRANSTON PRINT WORKS POND DAM

PLATE D-12

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME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